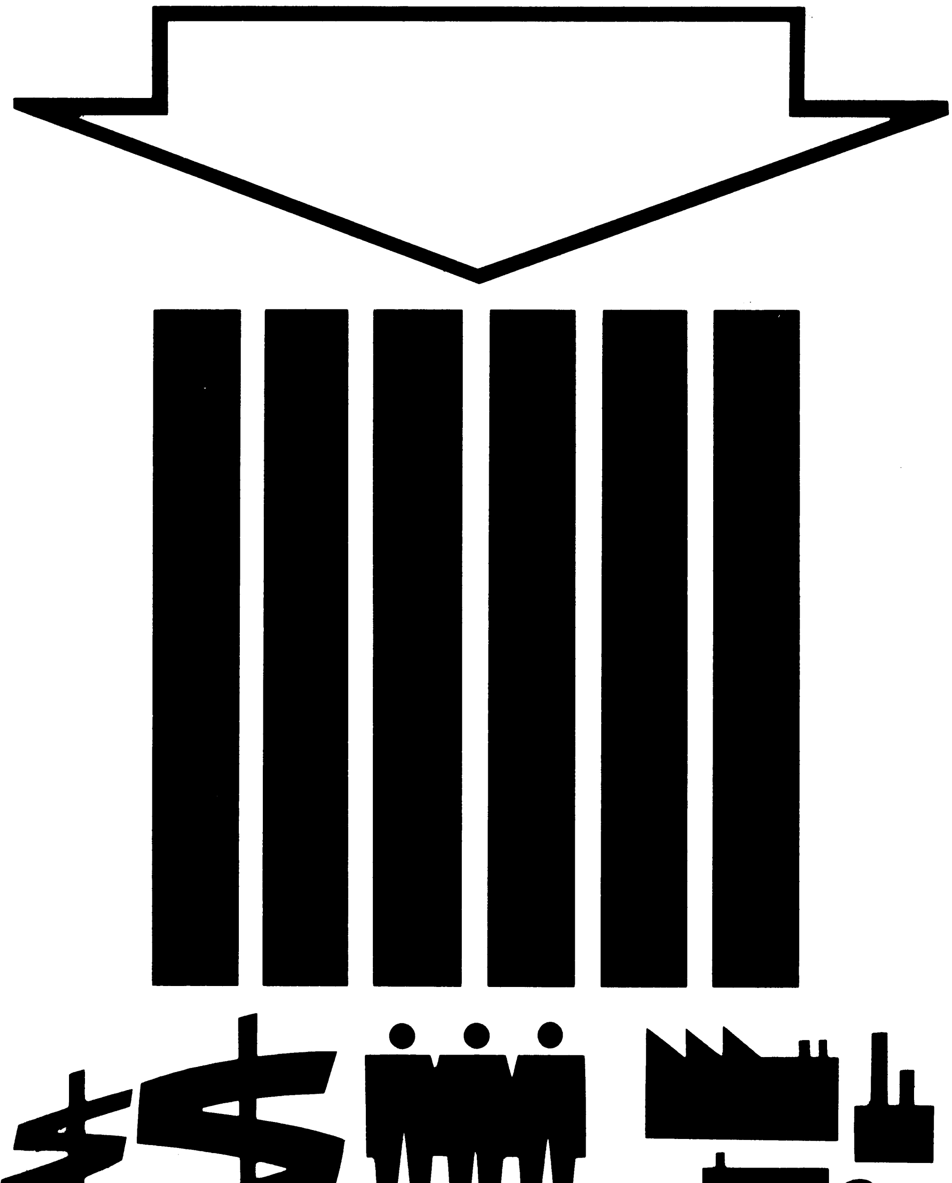
# REGIONAL DEVELOPMENT AND PLAN EVALUATION

# The Use of Input-Output Analysis

U.S. Department of Agriculture

Economics, Statistics, and Cooperatives Service

Agriculture Handbook No. 530



REGIONAL DEVELOPMENT AND PLAN EVALUATION: THE USE OF INPUT-OUTPUT ANALYSIS. By Robert McKusick, Nelson Bills, Richard Clark, Clifford Jones, Robert Niehaus, Charles Palmer, Sterling Stipe, John Wilkins, and Linda Zygadlo. Natural Resource Economics Division; Economics, Statistics, and Cooperatives Service; U.S. Department of Agriculture. Agriculture Handbook No. 530.

## ABSTRACT

The Water Resources Council's Principles for Planning Water and Land Resources and Standards for Planning Water and Land Resources require multiple objective planning and evaluation of natural resource use. Within that framework, a regional development account must be prepared for each alternative plan considered in the plan evaluation process. This report examines the uses and limitations of input-output (I-O) analysis in the formulation of the regional development account. The information needs of planners and economists evaluating plans in terms of regional development are identified and I-O's capability to provide some of these data is examined. An application section demonstrates the correct procedures for using regional input-output techniques in the estimation of secondary market impacts of plans, and identifies the limitations of using multipliers in isolation from the I-O model. The report emphasizes evaluating the feasibility of resource plans for a regional economy, as opposed to project justification.

Key Words: Input-output, Regional development and planning, Water Resources Council's Principles and Standards, Multipliers

## ACKNOWLEDGMENTS

This report is based on work done by the Economics, Statistics, and Cooperatives Service as part of its program of planning assistance to the Soil Conservation Service in the small watershed and resource conservation and development programs. The cooperation and financial support of the Soil Conservation Service in this study is greatly appreciated.

In addition to the Soil Conservation Service, we wish to thank the many individuals who participated in seminars and provided review comments throughout the study; in particular, Harry Ayer, Neil Cook, Clark Edwards, Roy Gray, Chuck Handy, Norm Landgren, Jim Sayre, Gerald Schluter and John Stierna. Finally we would like to recognize the excellent work of Linda Stallard in table formating, proofing, and typing the report.

Washington, D.C. 20250 May 1978

# PREFACE

This study examines the use of input-output (I-O) analysis in the plan evaluation process for water and related land resources by the Federal Government. An I-O model depicts the supply and demand relationships of an economy in equilibrium and estimates the indirect economic changes which would occur if a plan were implemented. This study examines the appropriate use of I-O models in U.S. Department of Agriculture (USDA) planning efforts, and presents applied examples of the use of the I-O multipliers and models consistent with the Water Resources Council's Principles for Planning Water and Land Resources and Standards for Planning Water and Land Resources. Although the original objective of the study was to concentrate on I-O multipliers, models, and application, the researchers first determined the economic information needs associated with regional development, and assessed quantitative methods used to develop this information.

I-O analysis is a widely used tool; however, multipliers are frequently applied incorrectly. This study should be useful to researchers currently using I-O analysis as well as individuals with very limited exposure to I-O techniques. While the study should be useful to planners at the Federal, State, and local level dealing with regional planning, it is specifically oriented to USDA economists formulating and evaluating plans under various USDA resource programs.

This study and report were funded by USDA's Soil Conservation Service. A team of economists from the Economics, Statistics, and Cooperatives Service, Natural Resource Economics Division, prepared this report. Although the final report is a total team effort, each chapter and appendix had principal authors. They are listed in the Table of Contents. Robert McKusick, project leader and editor, and Linda Zygadlo coordinated this report.

CONTENTS

## HIGHLIGHTS

This study focuses on the use of input-output (I-O) analysis to estimate the direct and indirect economic impacts on a region resulting from the implementation of a natural resource plan. Although I-O analysis has some limitations, it can provide detailed and reliable estimates of changes in a regional economy. I-O analysis is frequently underutilized and, more seriously, misused. Sector multipliers are often applied when the use of an I-O matrix would have provided a more detailed indication of plan effects on the regional economy. Multipliers are often applied to incorrect dollar values, resulting in inaccurate estimates of plan impacts on the local economy. The concepts underlying I-O analysis must be understood to use the tool properly.

Other limitations of the I-O approach in determining plan impacts on regional development should also be kept in mind. Economic analysis is only one input into the natural resource and regional decisionmaking process. There are legal, social, engineering, political, and ecological factors to consider. One should remember that after economic impacts have been estimated, they, along with other factors, must still be evaluated to determine whether they meet the overall planning objectives.

The study concludes that:

- Regional development should be included as an optional planning objective if regional objectives differ significantly from national objectives and if planning under national objectives would not solve regional problems and needs.

- If regional development is included as a planning objective, impacts of these plans on national economic development efficiency must be displayed so that local and national decisionmakers can compare costs, benefits, and other regional and environmental tradeoffs.

- This report should be used in conjunction with the Water Resources Council's (WRC) Guideline 5 Regional Multipliers report to provide direction and caution in the use of multipliers. Resource planners and economists need additional education in the application and use of I-O models and multipliers.

- I-O models have advantages over multipliers in project and program evaluation and plan formulation because regional development strategies can be developed and evaluated. Multiplier analysis provides only aggregate effects, whereas an I-O model identifies sectoral changes.

- Conventional I-O techniques can be used to study regional development strategies and impacts of resource plans. However, meaningful application depends on reliable estimation of structural relationships between sectors of an economy and a careful study of direct project and program effects and conversion of these effects into final demand changes on an industry-by-industry basis.

- There is a need to evaluate and compare alternative plans (those aimed at national economic development, regional development, and environmental quality) at the regional level to determine the significance of a highly concentrated economic base, high export leakages, major industrial shifts, and different trade patterns.

- I-O analysis should continue to expand into other areas such as energy, capital, pollution, and pesticides.

- I-O techniques and application should be improved in areas such as nonsurvey techniques to develop small area models from national and regional models; and national interregional models to link existing regional models to account for import/export flows in, and leakages from, small areas.

- There is a need to strengthen the data base used in I-O models, especially import/export data; data which relates final demand estimates to natural resource development, conservation, and management; and changes of technical coefficients over time.

# REGIONAL DEVELOPMENT AND PLAN EVALUATION: THE USE OF INPUT-OUTPUT ANALYSIS

## CHAPTER I. INTRODUCTION

by Robert McKusick

The problem of how to quantify and plan for regional economic growth and development has been a continual concern of local, State, and national planners. This concern has been renewed in the water and land resource area in the last 5 years with the adoption of the Water Resources Council's (WRC) Principles for Planning Water and Land Resources and Standards for Planning Water and Land Resources (referred to in this report as the Principles and Standards) (11) (58) (59) and the recent WRC publication of Guideline 5 Regional Multipliers (54) (60).* The Principles and Standards require a regional account display of tradeoffs of alternative plans based on national economic development and environmental quality objectives. Regional development is not used as an objective for developing plans.

There is a potential conflict in the requirement that regional plans be based on national economic development and environmental quality objectives which do not recognize regional development strategies and only display regional development impacts as an account entry. One of the purposes of Federal land and water programs is to solve regional resource problems and develop locally acceptable plans. The planning and evaluation criteria appear to be in conflict with the purpose.

Most regional, State, and county planners are interested in local socioeconomic evaluation and potential impacts of resource programs and plans. Local participants, planners, and decisionmakers need information on costs, benefits, and other regional and environmental tradeoffs before recommending and implementing a plan. This information cannot be just a localized national economic development account display, but has to reflect the regional economy and the interindustry and intraindustry flow of goods and services. Enough information has to be developed so that alternative regional development strategies can be prepared. Two major types of information are necessary: reliable estimates of structural relationships among sectors of an economy and direct and indirect economic impacts of projects and programs. Program and project activities have to be translated into shifts in final demand on an industry-by-industry basis.

Input-output (I-O) techniques are a useful method of estimating secondary economic effects of small watershed projects; resource, conservation, and

* Underlined numbers in parenthesis refer to citations in the Bibliography.

development project measures; river basin plans; and components of other regional development plans. While most resource agency administrators, planners, and researchers are familiar with the multiplier concept, there is much disagreement on the appropriate use, interpretation, and generation of multipliers. Recently, there has been a trend away from using the I-O model and table, and toward using multipliers in isolation from the model.

The need to appraise and evaluate I-O techniques is more critical given the recent WRC release of Guideline 5 Regional Multipliers (60) which is to be used for water and related land use planning. Although the publication identifies gross output multipliers by Bureau of Economic Analysis (BEA) areas, it does not relate project or program outputs to the multipliers and it lacks applied examples. There is also the potential problem of not recognizing the limitations of using multipliers in isolation from the I-O model. This report should be used in conjunction with the WRC "BEA Multiplier" approach to give direction and cautions in the use of multipliers.

The increased use of the gross multiplier approach, together with the dropping of regional development as an objective in the Principles and Standards and the tendency of the Office of Management and Budget to ignore regional development analysis as a criteria for funding projects, has put regional development in a minor supporting role in the Principles and Standards. Regional development will most likely not become a planning objective in the near future given the results of the Section 80 study (57). The Section 80 study investigated the possibility of including regional economic development as a chief planning objective. The study recommended that the present two objective framework (national economic development and environmental quality) of planning be maintained. Most national planners treat regional development as a residual account, with primary emphasis on the national economic development objective.

If regional plans are to be implemented and related to regional problems, preferences, and public involvement, then the regional development account entries have to be a part of the economic analysis of plan feasibility, and not an afterthought to justify a national economic development objective and plan.

## Purpose and Objectives

This report discusses and evaluates a general method for estimating the secondary market benefits and costs to a region of a public natural resource plan or project. And it evaluates the appropriate uses of I-O models in USDA planning and evaluation efforts.

Specifically, the report will:

1. Identify the general nature of regional development.

2. Discuss the basis for evaluating the secondary market effects of public resource plans on regional development.

3. Review and evaluate the WRC's Principles and Standards and USDA's guidelines, particularly as they relate to secondary market benefits and costs and regional development.

4. Outline the key features of I-O analysis, including its application to regions.

5. Examine procedures for using regional I-O techniques in the estimation of secondary market effects of plans.

6. Develop hypothetical models to demonstrate these procedures.

7. Identify future research needs and recommendations.

## Scope of the Study

The evaluation criteria and procedures presented in this report are applicable to a wide range of resource development plans and evaluation. Of particular interest are water and related land resource programs and projects which involve structures for flood control, irrigation, drainage, regional and rural community service, land treatment, recreation, municipal and industrial water supply, water quality, power, and navigation. The report emphasizes the evaluation and feasibility of resource plans for a regional economy, as opposed to project justification.

This study should aid economists and planners estimating secondary benefits and costs, and therefore improve planning for regional development. I-O analysis is used to measure changes in the level and composition of market economic activity that stem from and are induced by the regional plan. The I-O approach should encourage the analyst and planner to consider the regional economy as a complex entity of interdependent institutions, industries, and social and economic forces.

The evaluation of public natural resource plans involves many other issues and information needs, which are just as important as the appropriate measure of secondary benefits and costs. These include nonmarket implications of the plan, appropriate length of the planning period, choice of a discount rate, commodity output and resource pricing, and the social value of project or program outputs. This study addresses only a part, although an important part, of the total regional planning and evaluation process.

Appendix A lists and defines a number of terms commonly used in I-O analysis and in development plan formulation. Appendix B discusses the estimation of small area and substate models from State and national models. Appendix C shows examples of the impacts of regional plans in the Principles and Standards accounts.

## CHAPTER II. REGIONAL DEVELOPMENT

by Nelson Bills and Linda Zygadlo

This chapter traces briefly the evolution of the region as a unit for study, highlights the public's longstanding interest in economic growth and development, discusses the theoretical concepts commonly used to study regional growth, and emphasizes the limitations associated with these concepts. Distinctions between regional growth and regional development will become clear.

### The Region as a Unit of Study

Growth (or the absence of it) has been one of the Nation's oldest concerns, but the units of observation used for study and policy prescription have often been at one extreme or another. On the one hand, ideas about growth were related to individuals or to single firms. On the other extreme was concern with the growth of broad national aggregates such as total employment, total consumption expenditures, or total investment expenditures. National aggregates provide useful descriptions but they mask changes in different regions of the country. Analysis and policy prescriptions based on the intermediate unit of observation--the region, the community, or the small area--have emerged far more slowly.

The geographic area included within a region depends on the range and type of questions under evaluation. A region may be defined as a small rural community and its service area, a large, densely populated metropolitan area, or at the far extreme, a massive region encompassing several States.

Criteria for delineating a region are frequently complex. The region can be defined on the basis of a single criterion resulting in either a physical or geographic region, an economic region, a social or cultural region, or a region delineated on the basis of jurisdictional boundaries. Alternatively, the region can be defined in terms of any combination of the above criteria.

The concept of the region as a method of classification has evolved through two distinct phases reflecting economic advances from a simple agrarian economy to a complex industrialized system (15). The first phase saw the formal region concerned with uniformity and homogeneity of selected criteria. In the early definition of formal regions, the criteria were predominantly physical. Recently, economic and even social and political criteria have found widespread use. The more recent phase of classification resulted in the development of the functional region concerned with interdependence and defined on the basis of functional coherence. The functional region is generally composed of heterogeneous units such as cities, towns, and villages which are functionally interrelated.

Thus, regions may be formal or functional based on one or more criteria. Most importantly, for a regional delineation to be useful to economic planners and other social scientists, it must be large enough to be an economic unit--an area with economic relationships and interdependencies between industries--but small enough to show specific development problems. A 15,000-acre rural area consisting of two gas stations, a church, and numerous dairy farms cannot be considered an economic unit.

Viewed simplistically, formal hydrologic boundaries appear to be the obvious regional delineation for water resource planning; however, hydrologic boundaries generally do not make economic sense. Economic impacts usually cannot be analyzed within a hydrologic framework since economic interrelationships and interdependencies do not correspond to physical hydrologic boundaries.

Political boundaries--counties, for example--can be just as artificial as hydrologic boundaries for the purpose of analyzing economic interdependencies or relationships. But, a formal regional delineation on the basis of jurisdictional boundaries does have some practical advantages. For example, data are generally collected on a county basis. One of the most difficult tasks of regional analysis is to arrange these secondary data to correspond to the desired functional boundaries with reasonable accuracy.

Regional delineations based on jurisdictional boundaries can also work to the advantage of plan implementation. Local sponsorship of a project often involves an established political unit. Within this formal framework, program output can more readily be tied into other services and administrative responsibilities.

Several years ago, concerted efforts were undertaken to make the concept of a functional economic area operational. The rationale for the efforts are typified by Fox (13) who asserted that, "The major problem of rural society in the United States is our institutionalized belief that a rural society exists and can be manipulated successfully apart from society as a whole." According to Fox, many conventional dichotomies--agricultural and nonagricultural, rural and urban--are more confusing than useful. Such categories frequently obscure the fact, for example, that rural people include full and part-time farmers, the retired, commuters, and local businessmen providing services to them. Furthermore, all these groups are highly dependent upon industrial urban centers.

Efforts have been made to combine political jurisdictions--most often counties--to delineate regions that more closely coincide with functional economic areas. During the late 1960's and early 1970's, BEA delineated 173 multicounty economic areas throughout the Nation to be used for the OBERS projections; 1/ these functional areas have been designated as BEA economic

---

1/ The OBERS projections were developed for the Water Resources Council to be used in comprehensive planning for the use, management, and development of the Nation's water and related land resources. The OBERS program develops and maintains projections of population, economic activity, and land use for the Nation and its geographic subdivisions.

areas. Central place theory provided the conceptual basis for the delineation of the functional multicounty areas, generally using Standard Metropolitan Statistical Areas (SMSA's) designated by the Office of Management and Budget as the centers. The BEA functional economic area identification was one of the first nationwide multicounty delineations. It has been widely used in conjunction with water resources planning.

## Stages of Growth

Regardless of one's definition of a region, it is probably too ambitious to expect to have a theoretical approach that would be suited for all regions at all times. One of the oldest ideas about regional growth is that a region typically passes through stages of growth. 2/

The first stage is largely one of self-sufficiency. Virtually all production is based on natural resources, small amounts of capital investment are made, and there is only a limited amount of trade between individuals or businesses or regions. This stage can be identified early in the history of most U.S. regions.

Several stages can be constructed to follow the first stage. An intermediate stage would certainly involve greater specialization in production and growth in cash markets to facilitate trade. Greater trade volume also implies important improvements in transportation and the emergence of manufacturing. Often, manufacturing activities could be closely tied to the region's natural resources (processing of locally produced farm commodities, for example). More and more capital investment would characterize a region at this stage. Some local industries would decline while income and employment generated in manufacturing, trade, transportation, and the provision of various kinds of personal and professional services would greatly increase.

The idea of growth stages is still important, though the United States as a whole is clearly in a sophisticated or late stage of growth. Its importance stems from the fact that we find regions and localities which are at different stages on the growth spectrum. Theories and models we use to study regions ought to be applied with these differences in mind. Some of the most important ideas about regional growth have evolved from economic base theory. These ideas provide much of the theoretical support for the procedures discussed in this report. Consequently it is necessary to discuss the adequacies and inadequacies of economic base theory at some length.

Economic base theory takes into account the fact that growth and development in a region result in increased reliance upon specialization in production and trade. Trade--with whom and upon what terms--is a convenient point of departure for a theoretical framework within which one can study regional growth and development.

---

2/ We are indebted to North (39) (40) for much of the modern literature on regional growth stages but the general idea can be traced much further back in economic literature. Although the frame of reference was the entire American economy, these ideas were elaborated upon in the early 1800's. (4)

Economic base theory suggests that all economic activity (all production of goods and services) within a region can be separated into two categories--autonomous and nonautonomous (24, 32, 48). 3/ Nonautonomous production is distinguished by the fact that the products are delivered to consumers (both firms and households) within the region. On the other hand, autonomous production by definition includes production which is put directly in the hands of consumers outside the region.

The distinction between the above two kinds of production seems to be consistent with the notion that some producers realize returns to scale such that they can profitably produce at levels which exceed the demand in local markets (32). In other words, it can be presumed that the region or locality enjoys a comparative advantage relative to other regions in some lines of production. The region does some things well enough to participate in national or even international markets.

Base theory goes on to suggest that regional growth is ordinarily influenced by deliveries of locally produced goods and services to external markets. Exports--deliveries to external markets--are the prime movers of the local economy (48). 4/ All other economic activity, endogenous in the sense that production serves local markets, is considered to be passive in the local growth process. Either scale economies available locally do not allow profitable participation in export markets or possible export markets are too small to allow local producers to capitalize on the economies attendent to large-scale production.

At any rate, production solely for local markets is thought to be dependent on exporting industries. Nonexport activity owes its economic existence to interdependencies or linkages to export activity. These linkages could take the form of providing goods directly to local consumers (households) or providing raw materials and/or semifinished products to firms which export to the rest of the world.

Base theory also implies that a change in the volume of exports has a generative or multiplier effect on the local economy. The receipts from increased export sales are used in part to purchase local (endogenous) goods and services such as raw materials, haircuts, and so on although some of the receipts are leaked away through purchases (imports) from other regions.

Mechanically, the multiplier relationship takes the form of a base/service ratio:

---

3/ Many other terms besides autonomous and nonautonomous have found their way into the literature. The terms internal-external, exports-services, and endogenous-exogenous also receive considerable use in discussions of base theory.

4/ An example of an export business could be a food processing plant exporting its products outside the region, whereas the local grocery store is a nonexport business.

> The ...ratio purports to describe either (a) the proportion between total employment in a city's basic or export activities and total employment in its service or local activities or (b) the proportion between the increase in employment in a city's basic or export activities and the increase in its service or local activities (24).

For example, if export and service employment in a region were 1,000 and 2,000, respectively, then the base/service ratio would be 1,000:2,000 or 1:2. Alternatively, an additional employee producing for export markets might create or support two jobs in the local service sector, in which case the base multiplier would be ratio 3:1. That is, a total of three additional jobs would be created for each additional job to produce exports.

The initial experimentation with computations of base multipliers began in the 1930's. Several hundred economic base studies have been undertaken since that time. 5/ Some have been done for cities and some for rural areas. All have involved estimates of the base multipliers.

## Economic Base Theory Critique

Studies involving the identification of basic and service activities and the computation of base/service multipliers have been soundly criticized by economists, geographers, planners, government officials, and laymen. 6/

### Industry Mix

One of the more consistent lines of criticism has been that base studies perform well in description but poorly in prediction (2). Base/service classification is a useful way to characterize or describe a regional economy. But, it is not certain that a single base/service ratio can yield a useful estimate of the multiplicative effects associated with a change in export activity. In practice, a region or locality probably has several industries that participate in export markets. It is also likely that each industry has particular ties or linkages to local service industries. It follows that each industry exerts a particular multiplier effect on the local economy. An economic base study and a base multiplier, on the other hand, is computed to reflect the average response to a change in deliveries to export markets. All exporting industries are treated equally. Predictive results can be poor, therefore, simply because export expansion is sometimes concentrated in a few industries that deviate from the average.

---

5/ An exhaustive list of such studies is beyond the scope of this report. Urban planners, however, made many of the earlier empirical studies. Studies done in Detroit (8), Arlington County, Virginia (21), and Oshkosh, Wisconsin (1) are representative of this work.

6/ Richard B. Andrews wrote a series of articles dealing with the adequacies and inadequacies of economic base studies. His work appears in several issues of Land Economics in the 1953-56 period. Pfouts (43) collected these articles.

Consider a locality where, on the average, each additional job involving production for export markets creates two new jobs in local service industries. The base/service ratio is 1:2. If, in this example, the new production for export actually involved agriculture, the multiplier effect in the local area could be greater or less than average depending upon how dependent farmers are on local services relative to the average of all industries producing for export markets. If farmers are more dependent on local services than other industries, the multiplier would exceed the average. Perhaps it would be 1:3. If, on the other hand, farmers import most of their services (hired labor, seed, fertilizer, fuel, and so on) from another locality, the multiplier would be below the industrywide average. Perhaps it would be 1:1. These differences among local industries can be determined only with an analytical procedure which allows each industry to be treated separately.

## Sources of Autonomous Demand

Criticism has also been leveled at the basic assumption underlying base theory itself. Tiebout has argued that the concept of export base is a gross oversimplification for explaining growth:

> There is no reason to assume that exports are the sole or even most important autonomous variable determining regional income. Such other items as business investment, government expenditures and the volume of residential construction may be just as autonomous with respect to regional income as exports (49, p. 257).

In many regions, therefore, there would conceivably be a significant period of time when export sales were stable while pronounced increases in local income and employment occurred. The triggering mechanism for income and employment expansion could come from several other sources of demand for locally produced goods and services.

One of many examples could be residential construction. Several housing starts in a locality could employ local people and greatly increase the sales volume of local businesses who service the construction industry. The local economy experiences growth under these conditions even though exports of agricultural products, manufactured goods, and so on do not increase. A regional model flexible enough to consider several sources of autonomous final demand for a region's products would be a marked improvement on the conventional base multiplier.

## A Region's Capacity to Supply Goods and Services

For all practical purposes, the antithesis of the economic base hypothesis is simply that the forces that ordinarily influence regional growth and development operate within the region rather than from without. That is, autonomous demand for local production—outside forces—could be a factor, but growth might also be influenced by forces at work on the supply side of the equation. How can growth occur unless the region increases its capacity to supply goods and services? The region either obtains more resources (labor and capital, for example) to work with, or the productivity of existing resources (through new technology, for example) somehow increases. If so, a theoretical approach which dwells upon the growth-inducing effects of changes in demand but largely ignores factors influencing supply misses the mark to a large degree.

Like most other economic problems, it is probably true that studies of regional growth must ultimately involve consideration of demand factors and supply factors. Demand factors and supply factors work together in determining the economic course of a region. It is probably also true that the relative importance of supply factors and demand factors can differ from region to region and even within a region depending on the time span under consideration.

For example, if the time span under study is relatively short (say 1 year), one can argue that demand factors affecting growth in the region are likely to be more volatile than supply factors. Therefore, studies which concentrate on measuring the short-run effects of changes in demand could logically assume that the factors underlying the region's ability to supply goods and services do not change much. On the other hand, studies dealing with regional growth in the longer term would need to take into account demand for local goods and services and eventual changes in a region's capacity to supply goods and services.

The importance of supply and demand factors can be illustrated once again with a hypothetical example. Consider a locality where agriculture includes production of a feed grain such as corn. The problem could involve an evaluation of the immediate and longer term effects of additional corn production for export markets (shipments outside the region). An initial increase in corn production--perhaps under 5 percent--might have a negligible effect on the conditions under which local farmers produce (supply) corn for export markets. Accordingly, the multiplier effects could be quite stable. On the other hand, an annual increase of 5 percent each year for 10 consecutive years, (a compounded increase of 63 percent) could have pronounced effects on supply relationships for corn.

These changes may translate into increases or decreases in the multiplier effect of local corn production. Take, for example, fertilizer inputs. A large increase in corn production might require utilization of marginal soils with lower levels of fertility. A 50-percent increase in corn production might consequently require far more than a 50-percent increase in the use of commercial fertilizer. If the additional fertilizer were purchased from a local manufacturer, the correct multiplier effect would be larger than that implied by a model based on relationships that existed prior to the increase in corn production. Such a model would assume that the ratio between fertilizer use and corn production was the same after the change as before.

Conversely, local fertilizer manufacturers might be unable or unwilling to supply additional products to local corn producers. Local producers would turn to manufacturers outside the region and the correct multiplier effect would be smaller than that implied by a model that also assumes a proportionate increase in local fertilizer purchases as local corn production increases.

The above example illustrates two important aspects of regional multipliers. These analyses emphasize the response to a change in autonomous demand. In doing so, regional multipliers assume that purchases from local service industries change in constant proportion to the change in autonomous demand. The corn example demonstrates two cases where this assumption would be violated. The cases are (1) a change in input use and (2) a change in the geographical pattern of input purchases. A change in input use in the example resulted from shifts in the physical relationship between soil, fertilizer, and corn production. Several other factors--such as a change in technology or a change in an input process--could also exert a demonstrable effect on input use. And if input use changes, the multiplier for that industry can change.

The change in the geographical pattern of input purchases illustrated above stemmed from the inability of local farmers to purchase additional fertilizer from local manufacturers. Increased fertilizer expenditures leaked away from the local economy through imports from another region. The multiplier effects of new corn production are dampened accordingly. Of course, we could find examples that run in the opposite direction. There could be important cases of import substitution--local producers choose to increase their local purchases of inputs and substitute them for imported imports. Import substitution always enhances the multiplier effect of new production in a locality.

In general, we can say that trading patterns--imports vs. purchases from local service industries--must remain fixed if the multiplier is to be accurate. Similarly, we can generalize and say that input use must also be stable if the multiplier is to be accurate. This latter assumption is tantamount to requiring that, for any single industry: (1) technology is constant, (2) there are constant returns to scale or volume of production, and (3) the relative prices of all inputs remain constant.

In some industries, these assumptions could turn out to be too restrictive. They would be especially suspicious if they were applied in a study dealing with a longer time period and in an industry experiencing rapid output expansion. Under these circumstances, it is likely that producers will have both the time and the incentive to make adjustments in the resources used to produce goods and services. If a cost saving technological development becomes available, producers are likely to adopt it. If the price of any single input increases, they will use less of it and substitute another. If inputs can be purchased more cheaply outside their locality, they will reduce purchases from local suppliers. A model or analytical framework which allows some of these outcomes to be anticipated and incorporated into a planning study is a great improvement over the traditional economic base multiplier.

## Expansion in Autonomous Demand

We have discussed a theoretical framework that concentrates on the secondary or multiplier effects of increases (or decreases) in autonomous demand for goods and services produced within a region. The concept of autonomous demand was elaborated upon so that it became logical to think of several sources or kinds of autonomous demand. The primary sources were (1) exports to other regions or to international markets, (2) sales to household consumers residing outside the region, and (3) sales in support of local capital formation (residential construction, for example). 7/ Of these sources, export markets are likely to predominate in a region because production there is specialized.

In a study of secondary impacts, it is assumed that these various categories of demand are receptive to additional local production. 8/ For planning studies preoccupied with farm and forest products, it is assumed that new local production will find a ready outlet in export markets. It is also assumed that the export markets will absorb new products at a stable price. The additional production will be small relative to total national production. In terms most familiar to economists, it is assumed that the demand curve confronting local producers is perfectly elastic.

Few, if any generalizations can be made about the effect of this assumption upon the credibility of the study results. It is important, however, to take this dimension of the regional plan into account when a study is undertaken. There will be cases where the climate in export markets does not allow local producers to deliver additional products at a stable price. In these cases, of course, the issue of secondary impacts on the region may not need to be raised because primary impacts themselves may not be forthcoming.

---

7/ The list of autonomous demand sources can vary from study to study. The sources vary with the preferences of the analyst and the nature of the problem under consideration.

8/ This topic is common in project evaluation and in no way confined to the regional aspects of a plan. The topic will also be broached in accounting for the national economic development effects of the plan.

## CHAPTER III. REGIONAL DEVELOPMENT AND PLAN EVALUATION

by Linda Zygadlo and Robert Niehaus

Natural resource planning has long been carried out in the context of regional development. The original motivation for the passage of the Reclamation Act of 1902, for example, was the development of many parts of the arid western United States (20). More recently, the Resource Conservation and Development Program (RC&D) of the U.S. Department of Agriculture 9/ was established to develop the natural resources of selected regions and thereby to enhance the economic opportunities of the people of those regions. Development activities of the U.S. Army Corps of Engineers, the Federal Power Commission, and the Soil Conservation Service are all motivated in part by a national interest in the development of individual regions of the country. This chapter examines the plan evaluation process as it relates to the goal of regional development.

### Information Requirements of Plan Evaluation

The first step in this examination is to identify the principal types of information needed to evaluate the regional development implications of a natural resource plan. The required information is basically of two types: knowledge of the preferences and goals of the individuals affected by the plan and knowledge of the potential impacts of the plan.

In the broadest sense, the goals of society must be specified in order to assess whether a plan represents a progression toward or a regression from these goals. Specific goals may relate to developing the national or regional economy, preserving the quality of the natural environment, saving lives, reducing poverty, etc.

The second type of information needed to evaluate the regional development implications of a plan is knowledge of the potential impacts of the plan. The specification of goals is crucial in providing evaluation criteria; knowledge of potential impacts is necessary to relate the plan to those criteria. These impacts are directly related to the economic base of the region.

The potential effects of a plan may be sorted into four principal categories: (1) changes in market economic activity resulting from the plan; (2) changes in the demographic and social characteristics of the region; (3) changes in the governmental and legal institutions in the region; and (4) changes in the use and social value of the region's natural resources.

9/ Authorized under the Food and Agriculture Act of 1962 (P.L. 87-703).

## Secondary Market Impacts

In order to consider a problem of manageable size, this report concentrates on the secondary market effects of a plan. The importance of these impacts is that they represent a powerful potential mechanism for the diffusion of the effects of the plan throughout the region.

Secondary market effects of a plan are the second, third, etc., rounds of economic ripples created by a primary impact on an economy. They may occur in two ways. First, they may result from changes in the output of industries which supply inputs to the primary impact activities and to the implementation of the plan itself. These are the so-called backward linkages that are induced by the plan. Secondary effects may also be due to changes in the output of industries which use the products of primary impact sectors as inputs to their own production processes. This second phenomenon is the forward linkage that stems from the implementation of the plan.

The basic concepts involved can be illustrated by the simple diagram shown here as Figure 1. Suppose only one activity--agriculture--is immediately affected by the plan. This activity is considered the primary impact sector. Any effects induced by the change in agricultural output on the chemical, machinery, and other input industries, and on resources used by these industries, are backward linkages. Any effects stemming from the change in agricultural production on the transportation, processing, and merchandising sectors, as well as on final consumption, are forward linkages.

## Secondary Market Effects for the Region and Nation

Based on our interpretation of secondary market effects, it is logical to ask when they are important for a region. Resolution of this question is always an empirical issue, and the answer varies greatly between regions and between plans. The critical determining factor is the spatial location of the industries and the physical and human resources affected by the plan. To the extent that these related industries and resources are located outside the region, the predominant portion of any secondary market effects will be felt outside the region.

At the same time, two factors indicate potential secondary market effects within the region, even when the related industries and resources are located outside the region. First, it is possible that new investment might be induced in these industries and resources in the region as a result of the plan. Second, there may exist trade linkages between regions that would lead to feedback effects within the study region as a result of changes outside the region. From an empirical point of view, determining the spatial location of present industries and resources, and evaluating the likelihood of related investment, are the most difficult problems to resolve.

While specific regions may experience secondary market effects of a plan, it is not clear that these are relevant to the Nation. The secondary effects of plans are presumed to be negligible from the national point of view assuming that: (1) the national economy is operating near full employment of its

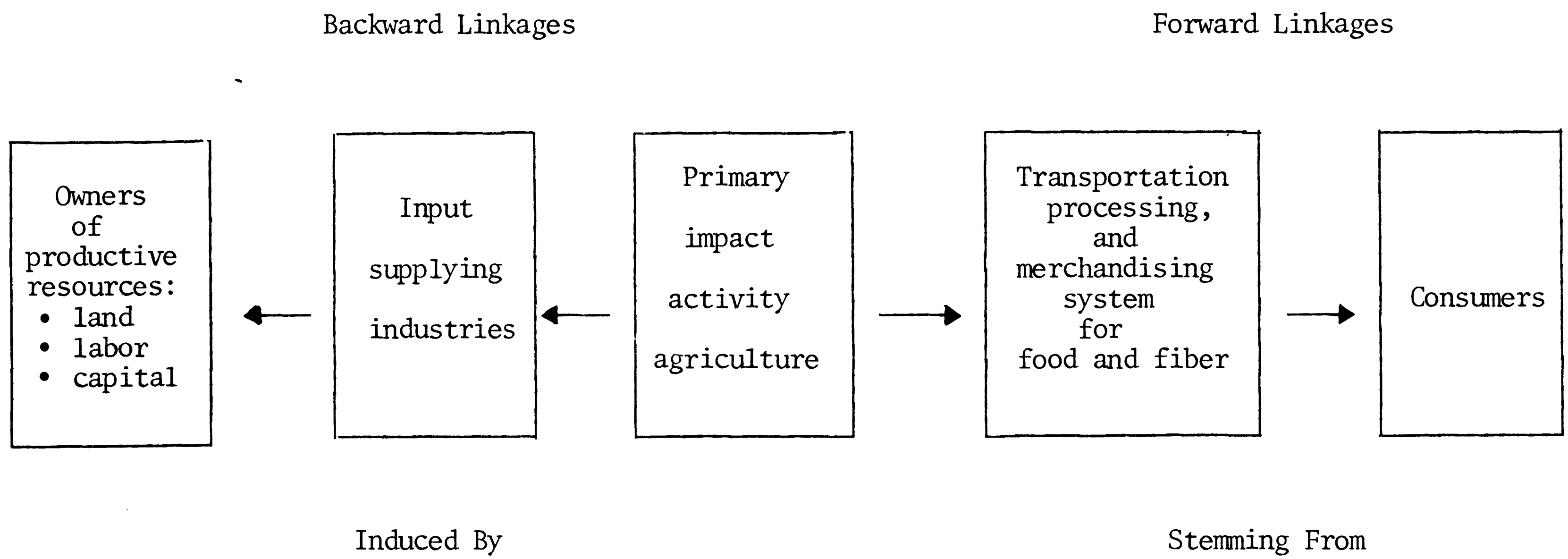



Figure 1. Secondary Market Impact Classification

physical and human resources without implementing the plan; (2) resources are sufficiently mobile; (3) economic decisionmakers possess sufficient information about the economic system; and (4) competition between firms and individuals is sufficiently pervasive. Under these assumptions, any output changes in industries secondarily affected by the plan will be offset by changes in other industries. Expansion or contraction of output and employment of resources in one industry in a region will result in opposite changes in output and employment in another industry in another region. The national economy returns to full employment after all these changes have had time to work themselves out. Only the composition of output and the spatial employment of resources is affected.

However, there are situations in which regional benefits from a plan are national gains as well. These situations occur when the assumptions specified above are not true. Suppose a region possesses labor and capital resources which would be underutilized in the absence of the plan, but which would be employed with the plan. Then, these regional increases in income and employment may be counted as both regional and national gains from the plan.

## Evaluation Procedures and Regional Development

In 1965, the Water Resources Council was established as an independent executive agency to coordinate the growing number and expanding scope of Federal water resources planning and action programs. In 1973, WRC issued the Principles and Standards (58)(59) to supplement earlier planning guidelines. Since that time, the Federal Government has made procedural interpretations of the Principles and Standards to guide planning work.

Planning and evaluation procedures outlined in the Principles and Standards and USDA Procedures for Planning Water and Related Land Resources (53) provide a consistent methodology for appraising alternative plans of water and land resource development.

The Principles and Standards specify that plans for the use of the Nation's water and land resources will be directed toward improving the quality of life through contributions to two objectives: national economic development and environmental quality. Two other accounts, regional development and social well-being, are required for each alternative plan. It is required that at least one plan be formulated to optimize the national economic development objectives and one plan to emphasize the environmental quality objectives. Other plans may be developed emphasizing the various components of the two objectives. Each plan must evaluate the quality of life in terms of beneficial and adverse effects displayed in the four accounts: national economic development, environmental quality, regional development, and social well-being.

Beneficial and adverse effects can be measured in monetary and nonmonetary terms. Beneficial and adverse effects are estimated in order to measure and display in appropriate accounts the net changes, with respect to the two objectives, that are generated by alternative plans.

Although it is difficult to imagine local cooperation and acceptance of a plan which is detrimental to a region's prospects for development, regional development per se is not included as an objective under the Principles and Standards. The regional development account formulated in the Principles and Standards measures the beneficial and adverse effects of a plan under six broad categories: (1) regional income, (2) regional employment, (3) population distribution, (4) regional economic base and stability, (5) environmental conditions of special regional concern, and (6) the effect of the plan on other specified components of regional development. 10/ The changes occurring in these six categories when "with" and "without" project analysis is made will provide information to evaluate a plan's fulfillment of a region's development objectives.

The account status of regional development as opposed to the objective status was a controversial issue throughout the formulation of the Principles and Standards. In the early drafts of the Principles and Standards, regional development was included as one of four objectives: national economic development, environmental quality, regional development, and social well-being. However, the final Principles and Standards include only the first two.

Since the Principles and Standards have been established to guide water and related land resource planning, ultimately their application will depend upon problems and needs found in the region. The Principles and Standards were not intended to be step-by-step instructions. Rather, they were developed to present the network of ideas and concepts that WRC prefers to incorporate into plans. Only the major ideas are shown, since it is impossible to identify all the secondary evaluation procedures which might be followed in any particular study. Therefore, if agencies take the Principles and Standards literally, flaws and omissions can result.

While public participation is viewed as an essential component of multiobjective planning, the expression of local values concerns, and goals will be relegated to a level of secondary importance under Principles and Standards procedures. Under the present Principles and Standards formulation, regional impacts are recognized only as by-products of plans to achieve the national economic development and environmental quality goals. Generally, the individuals most directly affected by a plan will be the residents in the area of plan implementation. It would seem, in view of stated intentions of the Standards and Procedures to involve the public in goal and planning formulation, that regional development should be included as a goal in the development strategy. If the project is going to be cost shared, then the impacts of the level of cost sharing on local goals and objectives should also be recognized in the planning process. In 1974, the regional development objective controversy resurfaced in Section 80(c) of the Water Resources Development Act of 1974. Under this act, WRC was directed to investigate and study the possibility of including, as a chief planning objective, regional economic development. The recommendation

10/ This general category could be used to document regional preferences. Using this element of the regional development account, the region could promote a plan that did not include economic growth per se, but rather, an improved income distribution. This category is only briefly presented in the Principles and never mentioned in the Standards.

of the study was to maintain the present two objectives--national economic development and environmental quality--and the four accounts display--regional development, social well-being, national economic development, and environmental quality--for plan formulation.

If a regional development objective were established, plans which would have net benefits on a combined national and regional basis, but would not have net benefits on the basis of national economic development alone, could be considered for implementation. Plans developed under a regional development objective could differ substantially from plans presently focusing on national economic development and environmental quality goals.

The regional development and social well-being accounts present a further difficulty when attempting to work within the Principles and Standards guidelines; the distinction drawn between regional development and social well-being is artificial because widely received concepts of regional development spill over into the social well-being account. Current thinking and policy are more directed toward welfare and rural development objectives such as fuller employment and higher per capita income rather than to the misleading standard of aggregate growth. When evaluating potential regional development impacts of a plan, it becomes difficult to disentangle the regional development and social well-being account entries. The result is a tendency to measure the economic impacts of regional development and largely ignore the corresponding social impacts which are more difficult to quantify. Social well-being and regional development are not mutually exclusive quality-of-life measurements. Certain aspects of the social well-being account would be more appropriately placed in the regional account. This would allow the measurement of both the quality and quantity elements of regional development. Account entries of aggregate income and employment changes representing the quantity aspects of regional development should be accompanied by anticipated changes in per capita income, unemployment and underemployment, and other distributional measurements to illustrate the quality aspects of regional development.

The present regional account entries measure the means for achieving goals as a proxy for the goals. One example is the treatment of changes in employment within the regional account. An increased number of jobs (means) does not necessarily indicate a decreased level of unemployment (goal), since it may only result in an inmigration of workers from other areas. In a like manner, an increased aggregate income level (means) does not necessarily result in an increased level of per capita income (goal). Per capita income increases or anticipated decreases in the unemployment rate are more indicative of the quality of life of local people than the aggregate changes presently identified in the regional account.

A further deficiency of the Principles and Standards is the failure to identify all the regional costs. Growth, particularly population increases, entails costs such as tax increases to cover the expenses of growth. School populations will grow, generating the need for larger school budgets; fire and police protection may need to be expanded; and local health services and the transportation system may be put under strain as a result of a growing population. In addition, if the wages received by the project workers are higher than local wages, wage rates may be driven up for types of labor, such as construction labor, which are demanded by the project. This would change the local income distribution. Housing and land values may become inflated due to population pressures. Social costs such as congestion, noise, pollution, and crime are also by-products of growth.

Under the Principles and Standards, regional development account changes in regional income resulting from plan implementation are viewed as beneficial and/or adverse effects. The Principles state:

> Where the regional development effects relate to increases in regional income, two classes of beneficial effects occur. These are:
> (1) The value of increased outputs of goods and services accruing within relevant regions resulting from a plan including, in addition to the value of outputs to users of the plan:
> (a) The value to the relevant regions resulting from the use in construction or installation of the plan of labor resources otherwise unemployed or underemployed.
> (b) Additional net income accruing to relevant regions from the construction or implementation of a plan and from other economic activities induced by operations of a plan.
> (2) The value of output resulting from external economies accruing within relevant regions.
>
> Adverse effects on the regional income include:
> (1) The value of resources within relevant regions required or displaced to achieve the outputs of a plan. This includes in addition to the value of resources contributed from within the relevant regions:
> (a) Payment through taxes, assessments or reimbursements by the relevant regions for resources contributed to the plan from outside the region.
> (b) Loss of assistance payments from sources outside the region to otherwise unemployed or underemployed resources and displaced resources within the region.
> (c) Losses in output in the relevant regions resulting from resources displaced and subsequently unemployed.
> (d) Loss of net income in the relevant regions from other economic activities displaced by construction or operation of a plan.
> (2) Losses in output resulting from external diseconomies within the relevant regions.

While indirect income accruing to a region as the result of a plan is considered a beneficial effect, a similar indirect income withdrawal is not recognized as a cost. The Principles and Standards acknowledge that any income displaced to achieve the outputs of a plan is a cost to the region; however, the present accounting procedure does not recognize that this income--prior to withdrawal from the region--also generated indirect income within the region. To quantify the indirect income increases accruing to a region as a benefit, and simultaneously to ignore the indirect income withdrawal from an area, automatically minimizes the identified costs to the region of plan implementation. The accounting procedures presently used to quantify the adverse effects of a plan on regional income should be altered to reflect the additional costs presently ignored.

A question with which the Principles and Standards do not deal is the treatment of inmigrating labor due to the implementation of a plan. If a local unemployment or underemployment problem exists, should regional gains in employment be adjusted to reflect only the new jobs filled by local residents? Given the local unemployment problem, are jobs filled by outsiders true regional gains?

Potential intraregional problems should be examined at some point in plan evaluation. Will a project result in a disparity of gains and losses within the region? For example, one county within a region may receive the benefits of a plan in the form of an increased tax base, while an adjacent county is burdened with the costs of a temporary population influx of construction families. Given present plan evaluation procedures, such problems are not identified.

Another question that emerges in reviewing Principles and Standards concepts and methodology is one related to consistent application of the Standards. As stated in the text, the Standards implement the Principles, employing consistent and uniform analytical techniques for judging beneficial and adverse effects of alternative plans (11, pp. 4, 19, and 22). Plans will likely be evaluated differently by each agency operating under the authority of Principles and Standards, since different interpretations are likely to be attached to the technical terminology in Principles and Standards, and differing analytical techniques will likely be used to identify and appraise the beneficial and adverse effects of alternative plans.

## Externalities and Secondary Market Effects

An externality exists when the social costs and benefits of the actions of an individual enterprise or institution diverge from the private costs and benefits to that decisionmaker. Externalities are also frequently referred to as spillovers. The basis of the externality concept is interdependence and the absence of compensation. Those receiving the benefits, whether monetary or nonmonetary, do not pay for them; and those causing others in society to have higher costs do not pay anything to offset these higher costs.

Some secondary market impacts are externalities in that they involve monetary (market) discrepancies between social and private benefits and between social and private costs. However, not all externalities are secondary market impacts since many externalities are not reflected in market transactions. At the same time, not all secondary market impacts can be broadly classified as externalities, since the essence of the concept of externalities is the absence of compensation and by definition market impacts involve compensation. Unfortunately, USDA procedures for planning water and related land resources do not maintain the traditional distinction between externalities and secondary impacts (53).

## Empirical Estimation of Secondary Market Effects

The conceptual analysis of secondary market effects presented at the beginning of this chapter sets the stage for a discussion of how these effects might be estimated. Some type of empirical procedure is necessary if the secondary market effects of specific plans are to be evaluated.

The essential feature of the analysis is the large number of potential interactions to be quantified. For example, a tile drainage investment project requires inputs from construction industries, which in turn increase their purchases of lumber, other materials, machinery, and labor. These industries, in turn, increase their purchases from their suppliers. At the same time, the greater wheat production resulting from the investment implies expansion of processing and marketing industries, and the circle of market effects continues to widen. Furthermore, these interactions tend generally to concern relationships between industries, rather than choices of technique within a single industry.

One type of empirical analysis is particularly suited to estimation under these conditions. Interindustry analysis permits the specification of a large number of transactions between industries and households. The analysis accomplishes this by simplifying the technical relationships within an industry, as well as the economic relationships between individuals and industries.

A number of other empirical models are available to researchers, though none are as suited to the analysis of secondary market effects as are I-O models. Econometric models are frequently more accurate than I-O analysis, but their stochastic nature makes them quite time consuming to use. Therefore, the number of relationships which can be accommodated is limited. Mathematical programming models represent a second alternative to I-O analysis. However, their optimizing character implies that they are more suited to the choice of a technique within an industry than to the analysis of relations between industries.

These other techniques are valuable in analyzing many potential aspects of natural resource plans. However, this report will pursue the hypothesis that I-O analysis is generally the best available approach to estimating the secondary market effects of plans. The following chapters discuss basic concepts of I-O analysis, and will apply the technique to specific examples of natural resource plans.

# CHAPTER IV. I-O CONCEPTS 11/

by Charles Palmer, Nelson Bills, and Robert Niehaus

Developed economies are characterized by a high degree of interdependence among producing sectors. Each economic sector not only produces goods or services but is a consumer as well, purchasing other goods and services for use in the production process. These relationships have been recognized for a long time. Francois Quesnay's Tableau Economique of 1758 dealt with circular flows between industries and general equilibrium concepts (4, p. 126). Walras stressed the interdependence between the production sectors of an economy with his general equilibrium model in the 1870's (4, pp. 459-463).

The first empirical application of the I-O model in the Anglo-American world dates from 1936 when Leontief published an I-O system of the U.S. economy (30). Leontief simplified Walras' generalized model so that equations associated with it could be estimated empirically. He used two simplifying assumptions. First, the large number of commodities in the Walras model was aggregated into relatively few outputs, one for each industrial sector. Second, supply equations for labor and demand equations for final consumption were abandoned. The remaining production equations were expressed in their simplest, linear form.

These simplifying assumptions provide for important contrasts between I-O and many other economic models. The assumption of linearity does not allow factor substitution or economies of scale. The passage of time is not accounted for, yet the purchase of inputs by one industry to make goods to sell to other industries implies a period analysis. The prevalence of joint products and multiproduct firms makes it impossible to aggregate only those firms with similar output and input structures together.

However, the model is simple and lends itself to empirical analysis. Its key variables are the outputs of sectors into which the economy is divided. Each sector's output consists of the sum of sales to all other sectors and final demand. The amount of each product which each sector consumes depends only on the level of output in the consuming sector. Equilibrium in the economy is attained when the output of each sector equals total purchases from that sector, these purchases being determined by the output of all other sectors.

## The Basic I-O Model

The key to Leontief's analytical system is the construction of the I-O or transactions table. The transactions table shows the flow of commodities

---

11/ I-O terminology and methodology are not consistent throughout the literature. Definitions presented in Appendix A clarify the terminology as used in this report.

from each of a number of producing sectors to all other consuming sectors, both intermediate and final. Data provided in the transactions table can be rearranged to derive a table of technical coefficients and a table of direct and indirect or total requirements from which I-O multipliers are derived. These tables receive extensive use in a regional study.

## The Transactions Table

A highly simplified, aggregated version of a transactions table is shown in table 1. The transactions table portrays the dollar flows of goods and services among sectors in an economy for a given accounting period, generally 1 year. Sales and purchases among industries are depicted in a matrix of rows and columns. Along each row is distributed the sales of a given industry to other industries and to ultimate consumers (final demand). Reading down the columns of the table, all purchases of the column sectors from the associated row sector are recorded.

Table 1—Illustrative transactions table

| Processing sector | Purchasing sector | | | | Total output |
|---|---|---|---|---|---|
| | Agriculture | Manaufacturing | Services | Final demand | |
| Agriculture | 10 | 6 | 2 | 18 | 36 |
| Manufacturing | 4 | 4 | 3 | 26 | 37 |
| Services | 6 | 2 | 1 | 35 | 44 |
| Primary inputs | 16 | 25 | 38 | 0 | 79 |
| Total outlay | 36 | 37 | 44 | 79 | 196 |

The distinction commonly made in economic analysis between the production of goods and services and their final disposition is reflected by dividing the sectors of the transactions table into four groups or quadrants, each representing either an intermediate or a final sector. Table 2 presents a generalized table with the four divisions.

The first quadrant shows the intermediate transactions (i.e, the flow of goods and services which are both produced and consumed in the process of current production). There are no maximum or minimum sectors required in this quadrant, but data limitations often limit the detail to 100 sectors or less. However, some national models have well over 400 sectors.

Final demand, including ultimate consumers' purchases from the producing sectors, are recorded in the second quadrant, while the third quadrant represents the primary inputs of production. As in quadrant I, the number of sectors depicting the amount of detail is left to the model builder. Table 1 has only

Table 2--Generalized transactions table

| | | | | Purchasing sectors | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Intermediate demand | Final demand | | | | |
| | | | | Agriculture, Mining, Manufacturing, Trade, Services, Finance | Household consumption | Govt. expenditures | Gross domestic capital formation | Exports | Total gross output |
| | | | | Quadrant I intermediate production & consumption | Quadrant II final outputs of producing sectors | | | | |
| Producing sectors | Intermediate inputs | Agriculture | 1 | $x_{11}$......$x_{ij}$......$x_{1n}$ | $C_1$ | $G_1$ | $1_i$ | $E_1$ | $X_1$ |
| | | Mining | . | . . | . | . | . | . | . |
| | | Manufacturing | . | . . | . | . | . | . | . |
| | | Trade | i | $x_{i1}$......$x_{ij}$......$x_{in}$ | $C_i$ | $G_i$ | $1_i$ | $E_i$ | $X_i$ |
| | | Services | . | . | . | . | . | . | . |
| | | Finance | n | $x_{n1}$......$x_{nj}$......$x_{nn}$ | $C_n$ | $G_n$ | $1_n$ | $E_n$ | $X_n$ |
| | | | | Quadrant III primary inputs to production | Quadrant IV primary inputs to final demand | | | | |
| | Primary inputs | Payments to | | | | | | | |
| | | Households | | $H_1$.......$H_j$......$H_n$ | $H_C$ | $H_G$ | $H_1$ | $H_E$ | H |
| | | Government | | $T_1$.......$T_j$......$T_n$ | $T_C$ | $T_G$ | $H_1$ | $T_E$ | T |
| | | Depreciation | | $D_1$.......$D_j$......$T_n$ | $D_C$ | $D_G$ | $D_1$ | $D_E$ | D |
| | | Imports | | $M_1$.......$M_j$......$M_n$ | $M_C$ | $M_G$ | $M_J$ | $M_E$ | M |
| Total gross outlays | | | | $X_1$.......$X_j$......$X_n$ | C | G | 1 | E | X |

one sector in quadrants II and III whereas table 2 shows both final demand and primary inputs broken down to four sectors each.

The fourth quadrant records the primary inputs and imports purchased directly by the final demand sectors, including such typical entries as income of government employees ($H_G$ in table 2) and imports consumed directly by households ($M_c$ in table 2).

Summing across a row, intermediate demand plus final demand measures total gross output of industry i. Thus, in an n sector model:

$$X_i = \sum_{j=1}^{n} x_{ij} + (C_i + G_i + I_i + E_i), \; i = 1, 2, \ldots, n.$$

Gross output = Intermediate demand + Final demand

Summing down a column, intermediate inputs plus primary inputs, yields total gross outlays of sector j. Thus:

$$X_j \sum_{i=1}^{n} X_{ij} + (H + T + D + M), \; j = 1, 2, \ldots, n.$$

Gross outlays = Intermediate inputs + Final inputs

We may also sum across the totals row and down the totals column to obtain the economy's total gross output:

$$X = \sum_{j=1}^{n} X_j + C + G + I + E$$

and

$$X = \sum_{i=1}^{n} Xi + H + T + D + M,$$

Since $\sum_{i=1}^{n} X_i = \sum_{j=1}^{n} X_j$, all intermediate flow totals can be cancelled out.

We then have:

$$H + T + D + M = C + G + I + E$$

That is, value added + imports = final demand. Note that this is true for the totals of individual sectors, though not necessarily for each sector alone. For example, referring to table 1, agriculture's sales to final demand (18 units) are not equal to agriculture's purchases of pricing inputs (16 units).

One last statement should be made concerning the components of the transactions table. Total gross output is not the same as gross national product; GNP is defined as the current market value of final goods and services produced in a given year. The computation of GNP has been developed to eliminate double counting; however, total gross output measures all transactions in the economy. The value of goods and services produced in a given year is deliberately counted more than one time. Final demand less imports would more closely correspond to the GNP.

## The Technical Coefficients Table

Table 3 is a table of technical coefficients derived from the illustrative transactions table (table 1). The entries in this table are to be interpreted as the requirements from each of the producing sectors at the left of the table in order for each sector at the top to produce $1 worth of output.

Table 3—Technical coefficients table

| Processing sector | Purchasing sector: Agriculture | Manufacturing | Services |
|---|---|---|---|
| Agriculture | 0.278 | 0.162 | 0.045 |
| Manufacturing | .111 | .108 | .068 |
| Services | .167 | .054 | .023 |
| Primary inputs | .444 | .676 | .864 |

These technical coefficients are determined by dividing the column entries for agriculture, manufacturing, and services in the illustrative transactions table (table 1) by the total outlay of the respective column. In this example, the manufacturing sector requires 16.2 cents worth of input from agriculture, 10.8 cents from manufacturing industries, and 5.4 cents from services in order to produce $1 of output. The remaining inputs to the manufacturing sector come from the exogenous or primary inputs part of the model.

The standard notation for technical coefficients (table 2) is computed as:

$$a_{ij} = \frac{x_{ij}}{X_j}, \; i, \; j = 1, \; . \; . \; .n,$$

where $x_{ij}$ is the sales by sector i to sector j and $X_j$ is the total purchases of sector j. By definition, $X_j = X_i$ for all endogenous sectors. The computation of $a_{ij}$ for all cells in the first quadrant of the transactions table results in a matrix of $a_{ij}$'s or a technical coefficient table.

## The Direct and Indirect Coefficients Table

One of the most important applications of the I-O model is to calculate the output levels in each sector of the economy that would be associated with changes in deliveries (sales) to final demand sectors of the model. For example, suppose that exports from the agriculture sector increase by $1. One can trace through the results using table 3. In order to sell an additional $1 worth of output to final demand, the agriculture sector must purchase 27.8 cents of output from itself, 11.1 cents output from the manufacturing sector, and 16.7 cents output from the services sector. These are first round transactions because for agriculture to sell 27.8 cents to itself, it must again purchase 7.7 cents more output (27.8 cents times .278) from itself, 3.1 cents (27.8 cents times .111) from manufacturing, and 4.6 cents (27.8 cents times .167) from services. The second round is not finished, because for manufacturing to sell 11.1 cents to agriculture, it must buy 1.8 cents (11.1 cents times .162) from agriculture, 1.2 cents (11.1 cents times .108) from itself, and 6 cents (11.1 cents times .054) from services. Similarly, the services sector must purchase inputs from all three sectors in order to sell 16.7 cents to agriculture. In just the first two rounds, agriculture has produced $1 for export, 27.8 cents plus 7.7 cents for itself, 1.8 cents for manufacturing, and .8 cents for services, totaling $1.38. Now, if one were to follow this process <u>ad infinitum</u>, the total amount each sector would be required to produce could be calculated. This process is the source of the final demand multipliers.

Leontief, using matrix algebra techniques, devised a much simpler method to determine the direct plus indirect requirements (total output requirements) resulting from a final demand change than the method described above. The Leontief method can be demonstrated using the information on final demands and total outputs from table 1 and with the information contained in table 3. From this information, one can specify the following system of equations:

$$X_1 = .278\ X_1 + .162\ X_2 + .045\ X_3 + Y_1$$

$$X_2 = .111\ X_1 + .108\ X_2 + .068\ X_3 + Y_2$$

$$X_3 = .167\ X_1 + .054\ X_2 + .023\ X_3 + Y_3$$

$X_1$, $X_2$, and $X_3$ are total outputs of the three endogenous sectors. $Y_1$, $Y_2$, and $Y_3$ are the respective processing sectors sales to final demand. The coefficients are the entries in the technical coefficients table (table 3).

In matrix notation, the system becomes:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} .278 & .162 & .045 \\ .111 & .108 & .068 \\ .167 & .054 & .023 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

Or, more simply stated,

$$X = AX + Y$$

where X is the vector of total outputs, A is the matrix of technical coefficients, and Y is the vector of final demands.

The above may also be written:

$$X_1 - .278\ X_1 - .162\ X_2 - .045\ X_3 = Y_1$$

$$- .111\ X_1 + X_2 - .108\ X_2 - .068\ X_3 = Y_2$$

$$- .167\ X_1 - .054\ X_2 + X_3 - .023\ X_3 = Y_3$$

or

$$(1 - .278)\ X_1 - .162\ X_2 - .045\ X_3 = Y_1$$

$$- .111\ X_1 + (1 - .108)\ X_2 - .068\ X_3 = Y_2$$

$$- .167\ X_1 - .054\ X_2 + (1 - .023)\ X_3 = Y_3$$

in matrix form:

$$\begin{bmatrix} (1 - .278) & - .162 & - .045 \\ - .111 & (1 - .108) & - .068 \\ - .167 & - .054 & (1 - .023) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

which may also be written:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} .278 & .162 & .045 \\ .111 & .108 & .068 \\ .167 & .054 & .023 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

and may be reduced to:

$$(I - A)\, X = Y$$

where I is the identity matrix, (I - A) is called the Leontief I-O matrix, and A, X, and Y are defined previously.

The coefficients are now in proper form to solve the Leontief system and find the vector of outputs required to sustain a given vector of final demands. The mechanical process is to first find the inverse of the Leontief (I - A) matrix. The Leontief inverse $(I - A)^{-1}$ is defined as the direct plus indirect coefficients, or total requirements matrix and is presented in table 4.

Table 4--Direct plus indirect coefficients table

| Processing sector | Purchasing sector: Agriculture | Manufacturing | Services |
|---|---|---|---|
| Agriculture | 1.4459 | 0.2678 | 0.0852 |
| Manufacturing | .1996 | 1.1628 | .0901 |
| Services | .2582 | .1100 | 1.0431 |
| Total or final demand multiplier | 1.90 | 1.54 | 1.22 |

To develop a solution, we must premultiply both sides of the (I - A) X = Y equation by the Leontief inverse as follows:

$$(I - A)^{-1}\, (I - A)\, X = (I - A)^{-1}\, Y$$

which reduces to:

$$X = (I - A)^{-1}\, Y.$$

Using the information in table form and the above matrix, we can develop the following system of equations:

$$X_1 = 1.4459\ Y_1 + .2678\ Y_2 + .0852\ Y_3$$

$$X_2 = .1996\ Y_1 + 1.1628\ Y_2 + .0901\ Y_3$$

$$X_3 = .2582\ Y_1 + .1100\ Y_2 + 1.0431\ Y_3$$

Returning to our example, when another region would like to purchase $1 more from the agriculture sector, we would like to determine the total increase in output resulting from this $1 increase in final demand. Using the above system of equations, and looking at the $1 increase only, agriculture sales to final demand ($Y_1$) would equal $1, and manufacturing ($Y_2$) and services ($Y_3$) sales to final demand would be zero. After multiplying through, agriculture total output ($X_1$) will be $1.4459, manufacturing output ($X_2$) equals $0.1996, and services output ($X_3$) would equal $0.2582. Summing the three outputs, we find the total increase in output resulting from a $1 increase in final demand of the agriculture sector to be $1.90. We have found the total output (both directly and indirectly) that this hypothetical economy is required to produce, in order for the agriculture sector to sell $1 output to a final demand sector.

## I-O Multipliers

This chapter has dealt with I-O concepts to demonstrate that they can be used to describe interindustry relationships in a regional economy. To be useful for purposes of planning, though, the analyst must move I-O results beyond the descriptive stage. Specifically, the model needs to be used to gauge the overall impact of production increases or decreases in any one sector of a regional economy. These overall impacts can be conveniently summarized by computing I-O multipliers.

From time to time, users of I-O results have been confused by both the theory and practice of multiplier computation. The purposes of this report are best served if a careful distinction is drawn between the theory and practice of I-O multiplier computation.

The theory behind the I-O multiplier is quite straightforward. The model is oriented toward an estimate, on an industry-by-industry basis, of the direct and indirect requirements associated with unit changes in deliveries to final demand. Unit or incremental changes in deliveries to final demand are solely responsible for multiplier effects in the I-O model.

The practice of multiplier computation, on the other hand, has become quite complex. The complexity stems from the fact that various kinds of multipliers can be derived for each industry. The variance stems from the unit of measure selected and the conventions used in defining exogenous final demand sectors.

## Units of Measure

I-O practitioners have popularized three units of measure for multiplier effects. They are (1) gross output or sales, usually referred to as final demand multipliers; (2) household income, referred to as income multipliers; and (3) employment, usually referred to as employment multipliers. Each measure can yield a different picture of a regional economy. There are differences because gross output/household income ratios and gross output/employment ratios can exhibit wide variation among industrial sectors in a regional economy. Such factors as wage rates, capital intensity, and the geographical pattern of resource ownership, for example, can cause fundamental differences in these relationships. Measurement of multiplier effects with several units of measure can capture many of these differences and yield valuable insights for water resources and other regional planning. Measurements in terms of household income and/or employment are particularly valuable in that they help sharpen the focus of a plan on the potential well-being of local citizens.

## Type I and Type II Multipliers

The second source of complexity in the practice of multiplier computation stems from conventions used in defining final demand sectors of a local economy. I-O practitioners once again have popularized two treatments of final demand generated by local household consumption. They have coined the terms Type I and Type II to keep the treatment separate.

The first treatment, the Type I multiplier, defines local household consumption expenditures (direct sales to local households) as being exogenous to the model. These multiplier effects can be measured in terms of gross output, household income, and/or employment.

The second treatment, the Type II multiplier, defines local household consumption expenditures as being endogenous to the model. That is to say, local households are treated as another industry in the model. Households sell labor, rent property, provide financing, and perform services for which they receive wages, salaries, interest, and dividends, and their purchases of locally produced goods and services are considered to be parallel with those emanating from other local industrial sectors. This procedure allows one to take into account the induced effects of new rounds of local household consumption expenditures on the local economy. These multiplier effects can also be measured in terms of gross output, household income, and/or employment.

There are sound economic arguments for treating local households as an industry in an I-O analysis. When output changes in response to a change in final demand, we know that household income increases by definition. New household income in turn is very likely to result in new household consumption expenditures. 12/ New consumption expenditures generate repercussions of their own on the local economy. The Type II multiplier is used to estimate the magnitude of these repercussions on an industry-by-industry basis.

## The Region and I-O Analysis

This chapter has dealt with the basic I-O analysis concepts in a very general way. The discussion has concentrated on the elements of an I-O model without relating the model to any specific geopolitical entity. Model application involves a particular problem setting, however. It is necessary to define the problem in specific geographic terms. The problem setting has important implications for the structure and empirical estimation of the model. For example, the analytical problems posed by application of the model to a multistate region, such as New England, would be different from those encountered when the model is applied to a multicounty, substate region, such as northwestern Arkansas. In turn, both of these sets of analytical problems differ from those involved in applying I-O techniques to the national economy.

Since the focus of this report is on the economies of subnational and substate areas, it is useful to discuss the most important problems encountered in applying I-O analysis to the study of regional economies of this size. Because extensive I-O modeling efforts take place at the national level, it is particularly important to note how analysis at the subnational level differs from national analysis. The following discussion will highlight several key characteristics of I-O analysis at the subnational regional level.

### Industry Size and Location

One basic difference between national and regional economic analysis concerns industry size and location. Regional economies are smaller than national economies in two ways: (1) there are probably a smaller number of different types of industries located in the region than in the Nation and (2) the output of each industry will be less for the region than the Nation as a whole. This means that the regional analyst must determine which industries are located in the region, and how much each of those industries produces. Producing sectors in the intermediate transactions matrix must be properly defined. Total gross output for each industry must also be estimated.

12/ Not all new household income is necessarily spent immediately. New income probably results in some combination of consumption and savings. Yet, this fact does not detract from the argument for a Type II multiplier because a combination of consumption and saving behavior is already accounted for in the I-O model. A difficulty does arise, however, if additional income leads to changes in the proportion of income saved and the proportion spent. Since there is some evidence that the fraction of income saved rises with income, the Type II multipliers may overestimate the output change associated with a change in demand.

## Technology

A second important difference between regional and national analysis is the variation in production technology. A national analysis is based on industry production techniques which represent an average for all regions of the country. A regional analysis, on the other hand, must consider the technical relationships applicable only to that region. These relationships may vary significantly from region to region because of differences in the age of the capital stock, relative prices, and resource endowments.

Differences in technology have important implications for regional I-O analysis. The table of regional technical coefficients should reflect regional production techniques, rather than national average technology. Often, however, empirical necessity dictates that national coefficients be used as first approximations to regional technical relationships. When this is the case, it is important that the coefficients be examined and occasionally adjusted to reflect local production conditions more accurately.

## Consumer Demand

Just as production technologies may vary from region to region, consumer demand patterns differ in different regions. Relative prices, consumer preferences, and personal incomes are key determinants of consumption expenditures on different commodities, and each of these factors can vary substantially between regions.

In I-O terms, these differences in consumption patterns must be reflected in the final demand sector of the interindustry model. Again, there is no reason to expect national average consumer demand patterns to reflect regional demands accurately. The correspondence between regional and national average patterns may or may not be close, and empirical research offers the only solution to the problem.

## Industry Composition

A fourth important characteristic of regional analysis is the difference between the composition of industries at the regional level and the composition of industries at the national level. This difference arises from the way the industries are aggregated and is distinct from the industry size and location consideration discussed above.

If any economic analysis is to be viable, it is necessary to aggregate individuals and goods into groups based upon like characteristics. In the case of industries, it is necessary to aggregate the production of reasonably similar commodities into industry groupings. For example, shoes may be grouped with belts, handbags, and leather jackets to derive a leather goods manufacturing industry.

It is possible, even probable, that the mix of product lines within similarly labeled industries will vary from region to region. At the national level, the composition of the leather goods industry represents an average over all regions of the composition of the industry in each region.

Regional I-O analysis must take into account these differences in industrial composition between regions. The technical coefficients for each industry in the regional model should be weighted averages for that region of the coefficients for the product lines and subindustries within that industrial sector. Again, use of national average coefficients may or may not result in significant distortions of the true regional industrial composition.

## Interregional Trade

A fifth notable characteristic of regional analysis is the importance of trade between the study area and other regions. This is in sharp contrast to a national level analysis for a country like the United States. The United States as a whole is a relatively closed economy. That is, most intermediate and final transactions take place within the economy itself; foreign trade is a fairly small proportion of the total.

For a region within the United States, however, it is clear that external trade by the region is a very important part of its total transactions. 13/ Very few small regions are self sufficient in the production of goods consumed within the region. Similarly, only infrequently does the region consume all it produces.

When I-O techniques are applied to regional economic analysis, they must reflect the importance of this interregional trade. There are basically two ways to incorporate the patterns of trade into interindustry analysis. The first technique is to construct the table of regional flows to reflect only those purchases and sales which take place within the region. Using this approach, all goods imported into the region by an industry, or imported directly to satisfy final demand, are lumped together into a single imports row, regardless of the region of origin. For example, imported leather, laces, buckles, and thread for the leather goods industry are given a dollar value and aggregated to a single import item. At the same time, goods produced in the region but sold to external buyers are aggregated into a single exports column without regard to industry or region of destination.

When the region under study is fairly small, and the focus of the analysis is that region in isolation (rather than closely related regions as well), this first technique produces satisfactory results. In fact, use of this method is so extensive that it has expropriated the more general name of regional I-O analysis.

---

13/ Because of the closed nature of the U.S. economy, the technical coefficients in the U.S. table are often thought of as representing a production function. However, due to the relatively large percentage of interregional flows in a regional economy, the regional technical coefficients table is not a close representation of a production function.

The second basic technique for dealing with trade between regions is usually termed interregional I-O analysis. As the name suggests, this method places greater emphasis on the interregional linkages between several related regions. In its most ambitious form, multiregional I-O analysis, the entire Nation is disaggregated into regions, and the trade linkages between each region and industry are specified.

The most important distinction between regional and interregional analysis is that the information on regional and industrial origin of imports and destination of exports that is aggregated and ignored in the former technique is retained and utilized in the latter. The obvious advantage of interregional analysis is that more information is available on the linkages between regions. Specifically, it is possible to take account of interregional feedbacks--changes in demand in one region which may trigger output changes in a second region, which in turn lead to further changes in output in the first region. The disadvantage of this more sophisticated method is its cost in terms of data and time required. For the most part, the empirical sections of this report will deal with the first technique discussed here.

## Data Acquisition

The sixth and final characteristic of regional analysis to be discussed here is the problem of data acquisition. Because there are significant costs involved in the collection of economic and social data, it is often necessary for government agencies and private research organizations to establish priorities concerning the kinds of data they will collect. Generally speaking, data on output, income, and employment at the national level of aggregation receive higher priority than do similar kinds of data for U.S. regions. Detail and statistical reliability are therefore the greatest at the national level, and become progressively worse as the unit of analysis becomes smaller.

Data problems at the multicounty, county, and subcounty levels can be especially acute. Typical data problems include the following: (1) small area national surveys are usually undertaken only once every 5 or 10 years, or less often, and are always several years out of date; (2) because it is illegal for the Government to disclose confidential business information about a single firm or individual obtained through surveys, there are often serious gaps in available information for small study areas so that disclosure can be avoided; and (3) the frequent need to conduct a study along nonpolitical boundaries (such as a river basin, or a functional economic area) means that it is often necessary to impute information about the study area, instead of obtaining it in a more direct fashion.

# CHAPTER V. THE USE OF I-O ANALYSIS IN PLAN EVALUATION

by Sterling Stipe, Richard Clark, and Clifford Jones

In this chapter, the basic concepts associated with I-O anlaysis will be applied to a hypothetical project, using an I-O model developed for a regional economy in the northeastern United States. In addition, the results of the example are displayed in the appropriate accounts as defined in the Principles and Standards. The demonstrated effects are not all inclusive. Some project effects do not lend themselves to I-O techniques. Also, the intent of this chapter is to demonstrate the more common uses of I-O, rather than to provide a complete guide to project analysis.

## An Overview of the I-O Tables

To reiterate, there are three tables or matrices basic to I-O:

(1) The transactions table (tables 1 and 5).
(2) The table of technical coefficients (tables 3 and 6).
(3) The table of direct plus indirect coefficients (tables 4 and 7).

Assume that a suitable transactions table for the study area has been obtained from either (1) primary data collected from local businessess and households or (2) the national I-O technical relationships using the secondary data methods explained in Appendix B.

The direct plus indirect coefficients matrix can be used to estimate the impacts of expected changes in final demands that will result from the alternatives under study. A given alternative may directly affect more than one local sector. Once the direct project effects on each sector are properly converted to final demand changes, 14/ the use of the direct plus indirect coefficients table will permit determining total gross output change in the whole economy and in each sector.

Three steps are necessary in estimating impacts with the direct plus indirect coefficents table:

(1) Estimate direct output changes by sector from all available data about expected direct effects of each component of the particular plan under study.
(2) Convert the direct output changes into final demand changes by sector, i.e., prepare a final demand change vector.
(3) Multiply the final demand change vector by the direct plus indirect coefficients matrix to obtain a gross output change vector.

---

14/ Example 11 in Chapter VI discusses the conversion of direct project effects to final demand changes.

Table 5--Transactions table for I-O model 1/

| Sectors | (1) Live-stock | (2) Other agricul-ture | (3) Agricul-tural services | (4) Mining | (5) Construc-tion | (6) Manufac-turing-food | (7) Manufac-turing-other | (8) Manufac-turing-wood | (9) Transpor-tation-finance-insurance-real estate | (10) Retail-whole-sale | (11) Services | Households | Other final demands | Total gross output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1,000 dollars | | | | | | |
| (1) Livestock | 5,655 | 407 | 1,535 | 0 | 0 | 8,803 | 302 | 0 | 60 | 0 | 381 | 842 | 51,149 | 69,134 |
| (2) Other-agriculture | 17,117 | 1,207 | 4,216 | 0 | 147 | 2,829 | 2,864 | 1 | 411 | 46 | 1,014 | 4,163 | 0 | 34,015 |
| (3) Agricultural services | 2,505 | 3,249 | 26 | 0 | 517 | 0 | 926 | 7 | 102 | 258 | 88 | 278 | 16,382 | 24,338 |
| (4) Mining | 6 | 83 | 0 | 331 | 2,761 | 5 | 2,453 | 5 | 21 | 10 | 0 | 0 | 5,787 | 11,462 |
| (5) Construction | 584 | 358 | 0 | 88 | 71 | 253 | 3,489 | 26 | 11,207 | 2,340 | 6,963 | 15,004 | 214,783 | 255,166 |
| (6) Manufacturing-food | 9,482 | 0 | 313 | 0 | 0 | 10,636 | 971 | 1 | 290 | 1,347 | 4,421 | 40,288 | 6,731 | 74,480 |
| (7) Manufacturing-other | 654 | 931 | 1,298 | 1,381 | 43,664 | 4,926 | 372,389 | 558 | 8,705 | 12,900 | 32,049 | 20,561 | 640,078 | 1,140,095 |
| (8) Manufacturing-wood | 3 | 206 | 49 | 0 | 3,158 | 59 | 2,084 | 634 | 12 | 168 | 28 | 65 | 0 | 6,466 |
| (9) Transportation-finance-insurance-real estate | 3,970 | 1,795 | 988 | 991 | 10,590 | 3,900 | 52,939 | 363 | 91,914 | 63,983 | 61,424 | 217,557 | 216,979 | 727,393 |
| (10) Retail-wholesale | 3,573 | 1,477 | 265 | 244 | 19,808 | 2,849 | 34,992 | 281 | 15,096 | 9,826 | 12,931 | 356,482 | 154,896 | 612,720 |
| (11) Services | 1,110 | 1,235 | 8 | 446 | 12,671 | 3,521 | 35,384 | 136 | 54,244 | 38,276 | 31,079 | 239,507 | 62,666 | 480,283 |
| Households | 17,545 | 12,375 | 7,479 | 5,071 | 67,236 | 10,085 | 316,679 | 2,499 | 269,146 | 241,957 | 198,729 | 102 | 1,629,596 | 2,778,500 |
| Other final payments | 6,928 | 10,692 | 8,163 | 2,910 | 94,543 | 26,614 | 314,622 | 1,953 | 276,185 | 241,609 | 131,176 | 1,883,651 | 2,244,958 | 5,244,004 |
| Total gross outlay | 69,134 | 34,015 | 24,338 | 11,462 | 255,166 | 74,480 | 1,140,094 | 6,466 | 727,393 | 612,720 | 480,283 | 2,778,500 | 5,244,005 | 11,458,056 |

1/ This is a transactions table taken from an I-O model developed for the Northeast United States.

Table 6--Technical coefficients table for I-O model 1/

| Sectors | (1) Livestock | (2) Other agriculture | (3) Agricultural services | (4) Mining | (5) Construction | (6) Manufacturing food | (7) Manufacturing other | (8) Manufacturing wood | (9) Transportation-finance-insurance-real estate | (10) Retail-wholesale | (11) Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Livestock | 0.081798 | 0.011966 | 0.063070 | 0 | 0 | 0.118193 | 0.000265 | 0 | 0.000082 | 0 | 0.000793 |
| (2) Other-agriculture | .247592 | .035485 | .173227 | 0 | .000576 | .037983 | .002512 | .000155 | .000565 | .000075 | .002111 |
| (3) Agricultural services | .036234 | .095519 | .001068 | 0 | .002026 | 0 | .000812 | .001083 | .000140 | .000421 | .000183 |
| (4) Mining | .000087 | .002440 | 0 | .028878 | .010820 | .000067 | .002152 | .000773 | .000029 | .000016 | 0 |
| (5) Construction | .008447 | .010525 | 0 | .007765 | .000278 | .003397 | .003060 | .004021 | .015407 | .003819 | .014498 |
| (6) Manufacturing-food | .137154 | 0 | .012861 | 0 | 0 | .142803 | .000852 | .000155 | .000399 | .002198 | .009205 |
| (7) Manufacturing-other | .009460 | .027371 | .053332 | .120485 | .182877 | .066139 | .326630 | .086298 | .011967 | .021054 | .066729 |
| (8) Manufacturing-wood | .000043 | .006056 | .002013 | 0 | .012376 | .000792 | .001828 | .098051 | .000016 | .000274 | .000058 |
| (9) Transportation-finance-insurance-real estate | .057425 | .052772 | .040595 | .086460 | .041502 | .052363 | .046434 | .056140 | .126361 | .104425 | .127891 |
| (10) Retail-wholesale | .051682 | .043423 | .010888 | .021288 | .077628 | .038252 | .030692 | .043458 | .020754 | .016037 | .036924 |
| (11) Services | .016056 | .036309 | .000329 | .038911 | .049658 | .047274 | .031036 | .021033 | .074572 | .062469 | .064710 |

1/ This is a technical coefficients table taken from an I-O model developed for the Northeast United States.

Table 7--Direct plus indirect coefficients table for I-O model 1/

| Sectors | (1) Livestock | (2) Other agriculture | (3) Agricultural services | (4) Mining | (5) Construction | (6) Manufacturing food | (7) Manufacturing other | (8) Manufacturing wood | (9) Transportation-finance-insurance-real estate | (10) Retail wholesale | (11) Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Livestock | 1.121370 | 0.021696 | 0.076651 | 0.000294 | 0.000562 | 0.155866 | 0.001003 | 0.000344 | 0.000473 | 0.000629 | 0.002712 |
| (2) Other-agriculture | .308029 | 1.061348 | .204981 | .000910 | .002253 | .090227 | .004779 | .001130 | .001271 | .000881 | .004160 |
| (3) Agricultural services | .070288 | .102413 | 1.023575 | .000326 | .002590 | .014479 | .001778 | .001506 | .000403 | .000625 | .000874 |
| (4) Mining | .001232 | .002983 | .000806 | 1.030310 | .011851 | .000752 | .003420 | .001308 | .000340 | .000206 | .000496 |
| (5) Construction | .016782 | .014061 | .004915 | .011608 | 1.004181 | .010069 | .007277 | .007217 | .019634 | .007379 | .019128 |
| (6) Manufacturing-food | .181476 | .005865 | .028088 | .001065 | .001528 | 1.193040 | .002518 | .001069 | .001784 | .003719 | .012469 |
| (7) Manufacturing-other | .067837 | .066417 | .099936 | .197265 | .289299 | .140056 | 1.498251 | .152226 | .037023 | .045094 | .119354 |
| (8) Manufacturing-wood | .002887 | .007758 | .004042 | .000722 | .014625 | .002242 | .004245 | 1.109258 | .000418 | .000554 | .000715 |
| (9) Transportation-finance-insurance-real estate | .130503 | .090596 | .079715 | .126394 | .088030 | .116778 | .096402 | .093070 | 1.165692 | .137433 | .173081 |
| (10) Retail-wholesale | .088313 | .056374 | .031508 | .033867 | .093334 | .068794 | .051675 | .057571 | .030136 | 1.023667 | .039611 |
| (11) Services | .059967 | .056145 | .023215 | .062477 | .077165 | .085655 | .061809 | .041804 | .097397 | .081472 | 1.091484 |
| Total final demand multiplier | 2.048684 | 1.485655 | 1.577432 | 1.465237 | 1.585418 | 1.877957 | 1.733155 | 1.466503 | 1.354571 | 1.301659 | 1.464084 |

1/ This is a direct plus indirect coefficients table taken from an I-O model developed for the Northeast United States.

All the above steps are important, but Step 2 is particularly crucial. It is very easy to misinterpret I-O results if Step 2 is mishandled. The conversion from direct output to final demand changes in specific sectors will at best require several assumptions. The validity of these assumptions is critical for proper interpretation of the impacts of the proposed change. Examples of the procedure and necessary assumptions will be presented in the subsequent sections.

## Estimating Direct Impacts

Suppose that Project X, one component of Plan A, is channel construction which will provide better outlets for farm drainage systems. The channel construction proceeds over a 3-year period. Funds totaling \$3 million 15/ are disbursed by the Federal treasury for project construction during the construction period. These funds are all paid to the construction industry. Farmers are aware that the project will make additional drainage possible on their individual farms. During the third year, when it becomes obvious that the project will be completed, some farmers begin to install tile drainage. Their expenditures for construction are expected to be small in year 3, but to rise in years 4, 5, and 6, and then become insignificant after year 8. Further assume that all farmers will contract the tile work; therefore, their expenditures will also be paid to the construction industry. It is expected that farmers will drain 12,000 acres at an average cost per acre of \$275 for a total of \$3.3 million.

Table 8 shows the assumed impacts of the drainage component that lead to the initial sector receipt changes in table 9. The analyst must consider whether or not the additional income to the construction sector will be spent by that sector in a manner similar to that depicted by the I-O model. Unless there are some obvious discrepancies between the additional expenditure and the existing expenditures, it is usually assumed that the model represents the correct expenditure pattern for the sector of interest (construction in this case).

The problem of new income to a sector not being spent in a manner similar to that depicted in the model can arise due to at least four reasons. First, a highly aggregated sector may create problems for the analyst. A highly aggregated sector is one in which several related, but different businesses are included. For example, in a model that contains one sector for agriculture in an area that is quite diverse agriculturally, that single agricultural sector would be highly aggregated. That sector might represent the purchasing and selling patterns of dairy farms, cattle feeders, cow-calf operations, dryland farms, and irrigated farms; the agricultural sector represents some sort of an average for all these kinds of operations. Any one of these operations may have expenditure patterns that diverge quite significantly from the average. If the project or plan impacts only one of these types of agricultural firms and its expenditure pattern diverges substantially from the average, then use

15/ This is a final demand change. The local construction sector is exporting channel construction purchased by the Federal treasury. The reasoning behind the identification of this \$3 million as final demand is discussed further on page 43.

Table 8--Initial changes in acreage drained, on-farm costs, and output due to the drainage component of Plan A

| Item | Units | Project year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 5/ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual area drained | Acres | | | 1,090 | 2,181 | 2,545 | 2,546 | 2,183 | 1,455 | | |
| Drainage cost 1/ | 1,000 dols. | | | 300 | 600 | 700 | 700 | 600 | 400 | | |
| Corn product 2/ | Bu. | | | | 32,700 | 65,430 | 76,350 | 76,380 | 65,490 | 43,650 | |
| Cumulative change 3/ | do. | | | | 32,700 | 98,130 | 174,480 | 250,860 | 316,350 | 360,000 | 360,000 |
| Value of cumulative change 4/ | 1,000 dols. | | | | 55 | 166 | 295 | 424 | 535 | 608 | 608 |
| Expended by Federal Treasury for channel construction | do. | 500 | 1,500 | 1,000 | | | | | | | |

1/ Average cost of drainage = $275 per acre in 1975 prices.
2/ Corn yield increase due to drainage = 30 bu. per acre. Value in this row is lagged one year from the year land was drained.
3/ Annual increased corn production due to drainage.
4/ Price of corn = $1.69 per bu. in 1975 prices.
5/ Annual effects continue for life of project at level obtained in year 10.

Table 9--Estimated changes in sector receipts by year due to the drainage component of Plan A 1/

| I-O model sector | Project year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 3/ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1,000 dollars | | | | | | | | | |
| Livestock | | | | | | | | | | |
| Other-agriculture | | | | 55 | 166 | 295 | 424 | 535 | 608 | 608 |
| Agricultural services | | | | | | | | | | |
| Mining | | | | | | | | | | |
| Construction 2/ | 500 | 1,500 | 1,300 | 600 | 700 | 700 | 600 | 400 | | |
| Manufacturing-food | | | | | | | | | | |
| Manufacturing-other | | | | | | | | | | |
| Manufacturing-wood | | | | | | | | | | |
| Transportation-finance-insurance-real estate | | | | | | | | | | |
| Retail-wholesale | | | | | | | | | | |
| Services | | | | | | | | | | |

1/ Derived from data in table 8.
2/ The construction row is a combination of expenditures by the Federal Treasury for channel construction and expenditures by farmers for tile drainage installation with an overlap of the expenditures in year 3.
3/ Annual effects continue for life of project at level obtained in year 10.

of the highly aggregated agriculture sector for impact analysis could be quite misleading. Unless the model can be disaggregated to several agricultural sectors, the user cannot do much to alleviate the problem. However, he should be aware of it and temper his conclusions accordingly.

A second cause of income not being spent as depicted in the model relates to the age of the model in use. Sectors whose input structures tend to change slowly are less susceptible to this problem than those that change quickly. If the industry being analyzed is changing rapidly, the analyst is on shaky ground using an older model for analysis. Many industries tend to change slowly so structural coefficients of a model are useful for several years.

A third possible source of expenditure deviations is that a project will bring into the local economy a new business or industry not represented by a sector in the existing I-O model. Suppose the project being analyzed is introducing irrigation into an area that has always been used for dryland crops and ranching. The expenditure patterns for irrigated farms is likely to be quite different from those in an existing model. Use of multipliers from an existing model without modifying it could lead to erroneous conclusions.

The fourth possible source of the problem comes about because expenditures for the project or plan are not typical for a sector that exists in the I-O model. However, if these expenditures are known and can be separated from the total, the analyst can adjust his procedure. Suppose the construction expenditures were typical except for the $500,000 to be spent in year 1 (table 8). Suppose these funds are to be spent by the construction sector entirely outside the economy being analyzed. The analyst can exclude that amount from his analysis of impacts on the local economy. An example is presented in Chapter VI.

For the hypothetical example being discussed, the previous four problems will be ignored. However, in many actual situations, these problems cannot be overlooked. In this sample problem, "other-agriculture" includes farm sales of crops and forest products, so it could be susceptible to the aggregation problem mentioned above.

Table 9 shows the receipts received by the sectors directly affected by the channel work and by the drainage component of Plan A, namely, construction and other-agriculture. These receipts must be reviewed to decide whether they (1) present total gross output changes; or (2) are themselves final demands. If they are total gross outputs, they must be reduced to final demands for proper use with the direct plus indirect coefficients matrix for impact estimation.

In the example under consideration, the construction sector is exporting channel construction to a buyer outside the local economic area (the Federal Government). Even though the construction takes place locally, the effect is similar to an export of goods. The money flows into the local economy from an outside source. Thus, Federal payments to the construction sector represent changes in final demand for the construction sector. When farmers buy tile drainage from the construction sector, they are engaging in capital formation. Farmers are deferring consumption in order to build (to form) additional capital when they invest in drainage. The money they use may be borrowed, it may come from savings, or it may be from current cash flow. This again represents a change in final demand for the construction sector. Since the tile systems will last more than 1 year, they represent a sale of goods that are removed from further processing in the local economy.

In years 1 and 2, the construction sector's receipts due to Project X are all from outside the project area and do not include any sales from one local processing sector to another. Therefore, these receipts can be considered to be final demand. They will generate some buying and selling among local sectors. This ripple effect will increase the construction sector's total gross output above the $500,000 received in year 1, and will increase the total gross output of other local sectors as well.

In year 3, the construction sector receives $1 million from the U. S. Government for channel work and $300,000 from farmers for tile drain installation. As explained above, the entire $1.3 million represents final demand which the construction sector must satisfy.

The sales of corn from increased yields on the drained land represent yet another type of receipt. In deciding how to use the model with respect to these receipts, the analyst must know the source of demand for the corn. Demand for additional feed grain, such as the corn used in this example, must exist if farmers are to sell additional corn. They must be reasonably certain that a market exists or they will not install drainage to increase production. The local elevator or grain dealer who buys from farmers is expecting to market the grain to local livestock feeders, dairy farms, and local grain processors, <u>or</u> to sell it (export it) outside the area. <u>16/</u> That portion that he sells locally remains in the local processing sector. It is further processed either through livestock or through milling companies, so it is not a part of final demand for the other-agriculture sector. The <u>exported part</u> is part of final demand and once estimated, its value can be shown as a final demand change for the other-agriculture sector. The amount of increased final demand for the livestock sector (and any other local sector which buys grain from other-agriculture) necessary for the livestock sector to purchase the <u>unexported</u> output of grain must be estimated.

Assume that a separate analysis shows that 50 percent of the additional corn production will be exported while 20 percent will be purchased locally by the livestock sector and 30 percent will be purchased locally by the manufacturing-food sector. In year 4, these percentages translate into $27,500, $11,000, and $16,500 respectively (table 10). Thus, the $27,500 is exported and goes in the model as a change in final demand for the other-agriculture sector. The $11,000 worth of corn purchased by the livestock sector will be purchased only if the livestock sector can experience an increase in its final demand. The direct plus indirect coefficients table (table 7) shows that for each $1.00 that the livestock sector delivers to final demand, the local economy will

<u>16/</u> The processing of the grain from the project is sometimes referred to as a forward linkage since the impacts in part go from the farms forward to processors. The impacts of the expected gains are sometimes referred to as backward linkages since all the impacts go from the farmer back to his suppliers of inputs.

purchase $.308029 from other-agriculture. Thus, the livestock sector final demand must increase by at least $35,711 17/ if it is to support the local economy in disposing of $11,000 worth of grain from other-agriculture 18/. The livestock sector will purchase inputs from other sectors also but those impacts will be accounted for when the final demand change sector is multiplied by the direct plus indirect coefficients matrix. By an analysis similar to that for the livestock sector, the final demand of the manufacturing-feed sector must increase by $182,872 19/ if it is to purchase an additional $16,500 from other-agriculture. 20/ Whether or not the impacts from these processing sectors are in fact due to the project is a crucial question. That question is addressed in a later section concerning implications of the direct impacts.

Table 10 reflects the assumption that after year 8 the direct impact on the construction sector has become insignificant. Any impacts after that time are secondary in nature and arise due to the increased annual sales by the other-agriculture sector which, other things equal, continue as long as the drainage system is functioning properly.

## The Time Question

The next problem to be considered is how the time stream of new final demands will be averaged. It would be possible to run the I-O model for each year but this would be costly in computer time and probably would not improve the analysis significantly.

---

17/ $11,000 ÷ $.308029 = $35,711 (see table 7 for coefficient).

18/ The $35,711 is probably an understatement of the necessary increase in final demand for livestock. The livestock sector undoubtedly purchases other items from the other-agriculture sector besides corn to support its final demands. For example, roughages and other feed grains would be needed to go along with the $11,000 worth of corn. So, the true needed increase in final demand for livestock would be ($11,000 + $ roughage purchase + $ other feed grain purchases)/$.308029. For purposes of this example, it will be assumed that corn is the only item purchased by the livestock sector from the other-agriculture sector.

19/ $16,500 ÷ $.090227 = $182,872 (see table 7 for coefficient).

20/ The previous analysis has treated the $55,000 in increased output as the change brought about by the drainage improvement only. As such it is not to be viewed as a constraint on increased production from the other-agriculture sector. In fact, it can be shown that total output in the other-agriculture sector must increase by an amount greater than the $55,000. The example assumed that $27,500 of the $55,000 due to drainage would be exported or go to final demand. By analysis similar to that in the above text, the $27,500 increase in final demand must be accompanied by an increase in gross output in that sector of $29,287. In addition, the change in the construction sector's final demand in year 4 of $600,000 (table 10) must be accompanied by a $1,352 expansion in other-agriculture. So, total gross output in the other-agriculture sector will change by $58,039 ($11,000 + $16,500 + $29,187 + $1,352 = $58,039). All of these effects are taken into account, however, by applying the multipliers for each of the respective sectors or by multiplying the final demand change vector by the direct plus indirect matrix.

Table 10--Final demand changes due to the drainage components, Plan A, Project X

| I-O model sector | Project year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 and each year thereafter 4/ |
| | 1,000 dollars | | | | | | | | |
| Livestock 1/ | | | | 35.7 | 107.8 | 191.5 | 275.3 | 347.4 | 394.8 |
| Other-agriculture | | | | 27.5 | 83 | 147.5 | 212 | 267.5 | 304 |
| Agricultural services | | | | | | | | | |
| Mining | | | | | | | | | |
| Construction | 500.00 | 1,500.0 | 1,300 | 600 | 700 | 700 | 600 | 400 | - |
| Manufacturing-food 2/ | | | | 182.9 | 551.9 | 980.9 | 1,409.8 | 1,778.8 | 2,021.6 |
| Manufacturing-other | | | | | | | | | |
| Manufacturing-wood | | | | | | | | | |
| Transportation-finance-insurance-real estate | | | | | | | | | |
| Retail-wholesale | | | | | | | | | |
| Services | | | | | | | | | |
| Other agricultural sales distribution | | | | | | | | | |
| 20% Livestock | | | | 3/ 11 | 33.2 | 59.0 | 84.8 | 107.0 | 121.6 |
| 30% Manufacturing-food | | | | 3/ 16.5 | 49.8 | 88.5 | 127.2 | 160.5 | 182.4 |
| 50% Export | | | | 27.5 | 83 | 147.5 | 212 | 267.5 | 304 |
| Total other-agricultual sales | | | | 55 | 166 | 295 | 424 | 535 | 608 |

1/ Inverse coefficient showing purchases from other-agriculture per one dollar sold to final demand is $.308029.
2/ Inverse coefficient showing purchases from other-agriculture per one dollar sold to final demand is $.090227.
3/ See discussion concerning implications of direct impacts.
4/ Annual effects continue for life of project at level obtained in year 9.

If the model could be run for each year, the annual secondary benefits could be combined with the annual direct benefits and discounted back to the present. But, given the accuracy level of the projected direct effects, it may be sufficient to synthesize 2 or 3 typical or average years and let these represent the annual project effects over some appropriate time period.

For this hypothetical example, three synthetic or typical years were prepared for the years 1-3, 4-8, and 9-12 respectively (table 11). The annual flows shown in table 10 were reviewed in choosing these time periods and final demands.

## Implications of Assumed Direct Impacts

The necessary changes in final demand and the yearly flows of these final demands have been estimated. Before proceeding with the analysis and developing conclusions concerning total Project X impact on the regional economy, consider what those final demand changes mean. We must be sure the changes in final demands can be reasonably attributed to the project being examined.

The $1.1 million (table 11) assigned to final demand for the construction sector for each of the first 3 years presents few problems. Since most of this money comes from outside the local economy and since it clearly would not happen without the project, it is valid to count this as a regional impact due to the project. The $300,000 (table 8) that comes from the farm sector for capital formation (drain installation) could not have occurred without the project because outlets for farm drainage systems were not adequate.

Detailed examination of the final demand changes for the remaining years is not as reassuring as for the first 3 years. Table 10 displays the yearly estimates by sector. Recall that the final demand changes for the other-agriculture sector beginning in year 4 are export sales of the increased corn production that was due to the project. If the export market exists and if the new production does not affect market prices, then this final demand change is logical. As discussed above, the final demand to the construction sector created by farmers installing drains is reasonable also (the 600, 700, etc., in the construction row).

The remaining two final demand increases, livestock and manufacturing-food, must be scrutinized more closely. Before one can legitimately say that the increased final demands in these two sectors are stemming from (due to) the plan or project, one must be willing to also say that the increased corn production was the only constraint on expanded livestock production and expansion in the manufacturing-food sector; this condition may or may not be the case. For example, if an area is already a net exporter of corn and a processor or feeder wanted to expand, he could purchase grain that is currently being exported. If such a situation exists, it is unlikely that increased corn production due to the drainage will bring about an expansion in these other sectors. A more logical assumption in this case would be to to place all of the increased grain production into the final demand change for the other-agriculture sector on the assumption that it will be exported.

Table 11--Final demands based on averaged values, drainage component, Plan A 1/

| I-O model sector | Project year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 and each year thereafter 2/ |
| | 1,000 dollars | | | | | | | | |
| Livestock | | | | 191.5 | 191.5 | 191.5 | 191.5 | 191.5 | 394.8 |
| Other-agriculture | | | | 147.5 | 147.5 | 147.5 | 147.5 | 147.5 | 304 |
| Agricultural services | | | | | | | | | |
| Mining | | | | | | | | | |
| Construction | 1,100 | 1,100 | 1,100 | 600 | 600 | 600 | 600 | | |
| Manufacturing-food | | | | 980.9 | 980.9 | 980.9 | 980.9 | 980.9 | 2,016.6 |
| Manufacturing-other | | | | | | | | | |
| Manufacturing-wood | | | | | | | | | |
| Transportation-finance-insurance-real estate | | | | | | | | | |
| Retail-wholesale | | | | | | | | | |
| Services | | | | | | | | | |

1/ The final demands for each sector for the first 3 years are an average of those that appear in table 10. Similarly, the sector final demand changes for years 4 through 8 represent averages of years 4-8 in table 10 and final demand changes for years 9-12 are averages of the yearly figures in table 10.
2/ Annual effects continue for life of project at level obtained in year 9.

Situations may exist where the project or plan (via increased production) would actually lead to expanded feeding or processing. For example, a sugar beet processing company may not be willing to build in a given area without stable and adequate supplies of beets. A large irrigation project that could guarantee at least 30,000 acres of sugar beets per year might be the key factor in the plant's location decision. If the demand for the sugar exists and one could be fairly confident that the plant would move in, then using the increased final demand for sugar necessary for the purchase of production from 30,000 acres of beets would be more logical. In this case, sugar beet production actually did constrain the output of a processing sector. Also the analyst should consider whether the model should be modified to reflect the presence of the new beet processing plant.

<u>Output Impacts of the Drainage Component</u>

The final demands shown in table 11 were multiplied by the direct plus indirect coefficients matrix to obtain estimates of the change in total gross output by sector to obtain the changes expected to result from the drainage component of Plan A. Table 12 shows the resulting yearly change for years 1-3, table 13 for years 4-8, and table 14 for years 9-12. The annual change shown for 9-12 can be assumed to continue on into the future for as long as the structure of the local economy is similar to the I-O model.

Table 12 displays the results of multiplying each element from the construction sector in the direct plus indirect coefficients table (table 7) by the $1.1 million average change in final demand experienced by the construction sector for the first 3 years of the project. Notice that total gross output of the construction sector increases to $1,104,600 which includes the $1.1 million change in final demand. The additional $4,600 total gross output change is due to the indirect effects (i.e, the construction sector increases its purchases from other sectors which in turn increase their purchases from the construction sector).

The total gross output change over all sectors that results from the initial $1.1 million change in final demand for the construction sector is $1,743,970. That total is the sum of the individual sector changes shown in table 12. The total gross output change can also be determined by multiplying the construction final demand multiplier (1.585418 from table 7) by the $1.1 million change in final demand.

The final demand changes in the livestock and manufacturing-food sectors that would be necessary to absorb new crop production in years 4-8 were shown in table 11. These final demand changes are based on the assumption that it is reasonable to expect both exports and regional processing of the new crop production to increase.

The results of final demand changes for years 4-8 multiplied by the direct plus indirect coefficients matrix are shown in table 13. There are four columns of total gross output changes in this table since there are final demand changes in four different sectors. The bottom line of table 13 (sector totals) could have been obtained by multiplying the sector final demand change by the final demand multiplier from table 7. It will be instructive for the reader to verify this for himself.

Note the model's implication, that for the livestock sector to increase its sales to final demand by $191,500 (table 11) it will purchase $59,000 of additional inputs from the other-agriculture sector, $13,460 from the agricultural-services sector, etc. Note that the construction and the manufacturing-food sectors receive the largest impacts.

Table 14 shows the impacts that extend into the future after all construction generated by the channel work and onfarm drainage has ended. For all these impacts to be valid, one must assume that the manufacturing-food and livestock sectors were being constrained only by corn production.

Table 12--Average annual total gross output changes by sector for years 1 through 3, drainage component, Plan A, Project X

| I-O model sector | Annual gross output change |
|---|---|
| | 1,000 dollars |
| Livestock | 0.62 |
| Other-agriculture | 2.48 |
| Agricultural-services | 2.85 |
| Mining | 13.04 |
| Construction | 1,104.60 |
| Manufacturing-food | 1.68 |
| Manufacturing-other | 318.23 |
| Manufacturing-wood | 16.09 |
| Transportation-finance-insurance-real estate | 96.83 |
| Retail-wholesale | 102.67 |
| Services | 84.88 |
| Total gross output change | 1,743.97 |

Table 13--Average annual total gross output changes by sector for years 4 to 8, drainage component, Plan A, Project X 1/

| I-O model sector | Livestock | Other-agriculture | Construction | Manufacturing-food |
|---|---|---|---|---|
| | 1,000 dollars | | | |
| Livestock | 214.74 | 3.20 | .34 | 152.88 |
| Other-agriculture | 59.00 | 156.55 | 1.35 | 88.50 |
| Agricultural services | 13.46 | 15.11 | 1.55 | 14.20 |
| Mining | .24 | .44 | 7.11 | .74 |
| Construction | 3.21 | 2.07 | 602.51 | 9.88 |
| Manufacturing-food | 34.75 | .87 | .92 | 1,170.21 |
| Manufacturing-other | 12.99 | 9.80 | 173.58 | 137.38 |
| Manufacturing-wood | .55 | 1.14 | 8.78 | 2.20 |
| Transportation-finance-insurance-real estate | 24.99 | 13.36 | 52.82 | 114.54 |
| Retail-wholesale | 16.91 | 8.32 | 56.00 | 67.48 |
| Services | 11.48 | 8.28 | 46.30 | 84.02 |
| Total due to each sector's final demand change | 392.32 | 219.14 | 951.25 | 1,842.03 |

1/ Total gross output change for each sector is obtained by summing across the row. Summing the bottom row across shows that total gross output change for the entire economy is $3,403,990.

Other Impacts due to the Drainage Component of Plan A

Now that total gross output changes have been estimated, the analysis can be extended to estimate changes in any variable that can be functionally related to total gross output. If the relationship between such items as pollution, water or land use, and sector gross outputs can be developed, we can determine multipliers for these nonmonetary items.

In previous sections, employment and income multipliers were discussed. During the development of most I-O models, data are generated that permit one to relate employment by sector and household income by sector to each sector's total output.

Employment

The direct employment effects and the employment multipliers for each sector of the hypothetical model are shown in table 15. The direct effects indicate the fraction of man-years of labor required by a sector for each $1,000 worth of gross output.

For example, the livestock sector has a gross output of $69,134,000 (table 5). Its total man-years of employment would be 4,217 (.061 X 69,134). It would take an expanded gross output of about $16,400 for employment to increase in the livestock sector by 1 man-year equivalent. These coefficients are based on the assumption of relatively full utilization of currently employed labor. If a sector was known to have significant underemployment at the time of the development of the basic model, use of the direct employment coefficients is likely to overstate the direct employment effects of increased output. Some industries may be able to expand output considerably without adding additional employment. The problem can be likened to one of changing labor efficiency. With high levels of underemployment, output per unit of labor input is lower than if that labor were fully employed. Use of the direct coefficient assumes that the labor efficiency that existed when the model was developed will also exist when output is changed. What in fact may happen is that output per unit of labor input increases but employment does not change. In such instances, the direct effects should be adjusted to reflect the higher output per unit of input.

The employment multipliers are based on the direct effects and the tables of direct and indirect coefficients (table 7). 21/ If the economy is plagued by underemployment, the multipliers will also overestimate employment effects. Just like final demand multipliers, the employment multipliers receive their impetus from changes in the sector's final demand. The final demand changes induce changes in gross outputs of the directly impacted sector which in turn creates impacts on other sectors. Without these final demand and resulting gross output changes, the employment multipliers mean nothing. Just increasing employment in a given sector without increasing output will not result in the

21/ Employment multipliers estimate the total employment generated in the economy per a one unit change in employment in a particular sector of the model.

employment changes shown by the employment multiplier. Furthermore, the employment multipliers must be used with the employment change associated directly with the final demand change that started the entire process. Use of the employment multiplier with employment changes due to total gross output changes will lead to overestimation of total employment effects. The following example demonstrates this point and the use of direct employment effects.

Table 14--Average annual total gross output change by sector for years 9 and beyond, drainage component, Plan A, Project X

| I-O model sector | Livestock | Other-agriculture | Manufacturing-wood |
|---|---|---|---|
| | | 1,000 dollars | |
| Livestock | 442.72 | 6.60 | 314.32 |
| Other-agriculture | 121.61 | 322.65 | 181.95 |
| Agricultural services | 27.75 | 31.13 | 29.20 |
| Mining | .49 | .91 | 1.52 |
| Construction | 6.63 | 4.27 | 20.31 |
| Manufacturing-food | 71.65 | 1.78 | 2,405.88 |
| Manufacturing-other | 26.78 | 20.19 | 282.44 |
| Manufacturing-wood | 1.14 | 2.36 | 4.52 |
| Transportation-finance-insurance-real estate | 51.52 | 27.54 | 235.49 |
| Retail-wholesale | 34.87 | 17.14 | 138.73 |
| Services | 23.67 | 17.07 | 172.73 |
| Total due to each sector's final demand | 808.83 | 451.64 | 3,787.09 |

The changes in employment by sector and in total for the average yearly effects of the drainage component for each of the three time periods are shown in table 16. The employment changes are found by multiplying the man-years of employment per $1,000 output (direct effects) by the change in output for each sector. The process is simple and provides more information than use of the employment multiplier alone.

The same total employment change can be determined with the employment multipliers shown in table 15. For years 1 to 3, the application of the employment multiplier is straightforward since only one sector has a change in final demand (see table 11). The change in final demand ($1.1 million) is multiplied by the direct employment coefficient (.029) for the relevant sector (construction). That multiplication gives the change in employment within the construction sector that is due to the final demand change. The resulting number is then multiplied by the employment multiplier for the construction sector (2.03). The process is:

Step 1

| Change in final demand | | Employment/$1,000 gross output | | Employment change due to final demand change |
|---|---|---|---|---|
| 1,000 dollars | | Man-years | | Man-years |
| 1,100 | X | .029 | = | 31.9 |

Step 2

| Employment change due to final demand change | | Employment multiplier | | Total change in employment |
|---|---|---|---|---|
| Man-years | | | | Man-years |
| 31.9 | X | 2.03 | = | 64.76 |

The 64.76 is the employment change in the entire economy and is equivalent to the 64.807 in table 16 except for rounding differences. If one had not gone back to final demand but had used the employment effect due to the change in total output (32.033) times the multiplier he would have overestimated total employment by about a fourth man-year (32.033 X 2.03 = 65.03). The error is not great for this sector, but for other sectors it could be much larger.

Table 15--Direct employment effects and employment multipliers

| I-O model sector | Man-years per $1,000 of gross output (direct effects) | Employment multipliers |
|---|---|---|
| Livestock | 0.061 | 1.80 |
| Other-agriculture | .061 | 1.35 |
| Agricultural services | .021 | 2.40 |
| Mining | .067 | 1.33 |
| Construction | .029 | 2.03 |
| Manufacturing-food | .022 | 2.82 |
| Manufacturing-other | .052 | 1.70 |
| Manufacturing-wood | .044 | 1.50 |
| Transportation-finance-insurance-real estate | .025 | 1.59 |
| Retail-wholesale | .065 | 1.20 |
| Services | .062 | 1.32 |

Use of the employment multipliers for the next two time periods is complicated by the fact that more than one sector's final demands are affected. Since the procedures for the next two time frames are similar, only time period two will be demonstrated. Once again, one must go back to the changes in final demands that started the process. The procedure for the second time period, years 4-8, is summarized below:

Table 16--Employment changes due to drainage component, Plan A

| Sector | Direct employment effects | Average yearly change for years 1-3 1/ | | Average yearly change for years 4-8 2/ | | Average yearly change for years 9 and beyond 3/ | |
|---|---|---|---|---|---|---|---|
| | | Gross output | Employment | Gross output | Employment | Gross output | Employment |
| | Man-years/ $1,000 output | $1,000 | Man-years | $1,000 | Man-years | $1,000 | Man-years |
| Livestock | 0.061 | 0.62 | 0.038 | 371.16 | 22.641 | 763.64 | 46.582 |
| Other-agriculture | .061 | 2.48 | .151 | 305.40 | 18.629 | 626.21 | 38.200 |
| Agricultural services | .021 | 2.85 | .060 | 44.32 | .931 | 714.29 | 15.000 |
| Mining | .067 | 13.04 | .874 | 8.53 | .572 | 2.92 | .196 |
| Construction | .029 | 1,104.60 | 32.033 | 617.67 | 17.912 | 31.21 | .905 |
| Manufacturing-food | .022 | 1.68 | .307 | 1,206.75 | 26.549 | 2,479.31 | 54.545 |
| Manufacturing-other | .052 | 318.23 | 16.548 | 333.75 | 17.355 | 329.41 | 17.129 |
| Manufacturing-wood | .044 | 16.09 | .708 | 12.67 | .557 | 8.02 | .353 |
| Transportation-finance-insurance-real estate | .025 | 96.83 | 2.421 | 205.71 | 5.143 | 314.55 | 7.864 |
| Retail-wholesale | .065 | 102.67 | 6.674 | 148.71 | 9.666 | 190.74 | 12.398 |
| Services | .062 | 84.88 | 5.263 | 150.08 | 9.305 | 213.48 | 13.236 |
| Total employment | -- | -- | 64.807 | -- | 129.260 | -- | 206.408 |

1/ Information for column 2 is from table 12. Column 3 is column 1 x column 2.
2/ Information for column 4 is a summation of each row in table 13. These figures represent total gross output change if all final demand changes discussed actually occur. Column 5 is column 1 x column 4.
3/ Information for column 6 is a summation of each row in table 14. Column 7 is column 1 x column 6.

Step 1

| Sector | Final demand change | X | Direct employment coefficient | = | Employment change due to final demand change |
|---|---|---|---|---|---|
| | 1,000 dollars | | | | Man-years |
| Livestock | 191.5 | X | .061 | = | 11.6815 |
| Other-agriculture | 147.5 | X | .061 | = | 8.9975 |
| Construction | 600.0 | X | .029 | = | 17.4000 |
| Manufacturing-food | 980.9 | X | .022 | = | 21.5798 |

Step 2

| Sector | Employment change due to final demand change | X | Employment multiplier | = | Total employment change |
|---|---|---|---|---|---|
| | Man-years | | | | Man-years |
| Livestock | 11.6815 | X | 1.80 | = | 21.027 |
| Other-agriculture | 8.9975 | X | 1.35 | = | 12.147 |
| Construction | 17.4000 | X | 2.03 | = | 35.322 |
| Manufacturing-food | 21.5798 | X | 2.82 | = | 60.855 |
| | Total employment change, all sectors | | | | 129.351 |

If employment changes related directly to total output changes were used with the multipliers of the final demand related changes, overestimation would have been more serious than for time period 1. For example, the employment change in the manufacturing-food sector would have been 25.790 man-years (1,172.28 (table 13) X. 022). Then, multiplication of that by the multiplier would have resulted in a total employment change of 72.73 man-years compared to the correct change of 60.86. Errors would have been made in the other sectors as well, resulting in an estimated total employment change of 144.7 man-years or about a 12-percent overestimate.

It has been shown that use of the direct labor coefficients or the employment multipliers give the same total employment effects. The first method, which used the direct employment effects along with the individual sector outputs, generates more information as to the distribution of the employment impacts than use of multipliers alone. Access to the complete I-O model (or at least a complete array of its output) is necessary for estimating the distributional impacts. The multipliers by themselves are useful, but are not nearly as useful as the complete model.

Income

The impact of the drainage component on household income is estimated in a way similar to employment. The proportion of each sector's expenditures going to households serves as the direct household effects for the model. These direct income effects along with the income multiplier for each sector are shown in table 17.

Once the total output change for each sector due to a given change in final demand is determined (tables 12-14), the individual sector income impacts can be estimated. The procedure is the same as that described for employment except that the income coefficients are used. The income effects for each of the three time periods are shown in table 18. This kind of information would be useful for filling out the account displays in Principles and Standards. From these data, one can see that income in agriculture is not significantly affected until the second time period. One can also see which sectors receive the largest income impacts.

Table 17--Direct income effects and income multipliers

| Sector | Direct income effect | Income multiplier |
|---|---|---|
| Livestock | .254 | 2.269 |
| Other-agriculture | .364 | 1.455 |
| Agricultural services | .307 | 1.610 |
| Mining | .442 | 1.358 |
| Construction | .263 | 1.743 |
| Manufacturing-food | .135 | 2.858 |
| Manufacturing-other | .278 | 1.821 |
| Manufacturing-wood | .386 | 1.421 |
| Transportation-finance-insurance-real estate | .370 | 1.352 |
| Retail-wholesale | .395 | 1.278 |
| Services | .414 | 1.389 |

Table 18--Income changes due to drainage component, Plan A

| Sector | Direct income effects | Average yearly change for years 1-3 1/ | | Average yearly change for years 4-8 2/ | | Average yearly change for years 9 and beyond 3/ | |
|---|---|---|---|---|---|---|---|
| | | Gross output | Income | Gross output | Income | Gross output | Income |
| | $1/$1 output | 1,000 dollars | | | | | |
| Livestock | .254 | .62 | .157 | 371.16 | 94.275 | 763.64 | 193.965 |
| Other-agriculture | .364 | 2.48 | .903 | 305.40 | 111.166 | 626.21 | 227.940 |
| Agricultural services | .307 | 2.85 | .875 | 44.32 | 13.615 | 714.29 | 219.287 |
| Mining | .442 | 13.04 | 5.764 | 8.53 | 3.770 | 2.92 | 1.291 |
| Construction | .263 | 1,104.60 | 290.510 | 617.67 | 162.447 | 31.21 | 8.208 |
| Manufacturing-food | .135 | 1.68 | .227 | 1,206.75 | 162.911 | 2,479.31 | 334.707 |
| Manufacturing-other | .278 | 318.23 | 88.468 | 333.75 | 92.783 | 329.41 | 91.576 |
| Manufacturing-wood | .386 | 16.09 | 6.211 | 12.67 | 4.891 | 8.02 | 3.096 |
| Transportation-finance-insurance-real estate | .370 | 96.83 | 35.827 | 205.71 | 76.113 | 314.55 | 116.384 |
| Retail-wholesale | .395 | 102.67 | 40.555 | 148.71 | 58.740 | 190.74 | 75.342 |
| Services | .414 | 84.88 | 35.140 | 150.08 | 62.133 | 213.48 | 88.381 |
| Total income change | -- | -- | 504.637 | -- | 842.867 | -- | 1,360.547 |

1/ Information for column 2 is from table 12. Column 3 is column 1 x column 2.

2/ Information for column 4 is a summation of each row in table 13. These figures represent total gross output change if all final demand changes discussed actually occur. Column 5 is column 1 x column 4.

3/ Information for column 6 is a summation of each row in table 14. Column 7 is column 1 x column 6.

The income multipliers permit estimation of the total income effects, but not the individual sector effects. As with the employment multipliers, the income multipliers must be applied to the change in income due to the change in final demand. Use of the income multiplier is demonstrated below for time periods 1 and 2.

## Time Period 1

### Step 1

| Sector | Final demand change | X | Direct household income coefficient | = | Income change due to change in final demand |
|---|---|---|---|---|---|
| | 1,000 dollars | | | | 1,000 dollars |
| Construction | 1,100 | X | .263 | = | 289.3 |

### Step 2

| Sector | Income change due to change in final demand | X | Income multiplier | = | Total change in income in $1,000 |
|---|---|---|---|---|---|
| | 1,000 dollars | | | | 1,000 dollars |
| Construction | 289.3 | X | 1.743 | = | 22/ 504.25 |

## Time Period 2

### Step 1

| Sector | Final demand change | X | Direct household income coefficient | = | Income change due to change in final demand |
|---|---|---|---|---|---|
| | 1,000 dollars | | | | 1,000 dollars |
| Livestock | 191.5 | X | .254 | = | 48.641 |
| Other-agriculture | 147.5 | X | .364 | = | 53.690 |
| Construction | 600.0 | X | .263 | = | 157.800 |
| Manufacturing-food | 980.9 | X | .135 | = | 132.422 |

22/ Except for errors introduced by rounding, this number is equivalent to the total of column 3, table 18.

Step 2

| Sector | Income change due to change in final demand | X | Income multiplier | = | Total change in income |
|---|---|---|---|---|---|
| | 1,000 dollars | | | | 1,000 dollars |
| Livestock | 48.641 | X | 2.269 | = | 110.37 |
| Other-agriculture | 53.690 | X | 1.455 | = | 78.12 |
| Construction | 157.800 | X | 1.743 | = | 275.05 |
| Manufacturing-food | 132.422 | X | 2.858 | = | 378.46 |
| | Total income change | | | | 23/ 842.00 |

Supply Constrained Industries

The quantity of any commodity sold in the market is jointly determined by demand and supply. A basic assumption underlying static I-O analysis is that both supply and demand are completely elastic. This implies that additional inputs are forthcoming at a constant price and that any quantity of product can be sold with no effect on price.

With regard to supply, it is generally true that the economy's total output or the output of an individual industry cannot expand indefinitely because of the scarcity of one or more of its inputs.

The potential output of a resource constrained sector can be estimated by dividing the resource supply by the direct resource requirement coefficient for that sector. This coefficient may be for water or land, or some other resource (for example, the acre-feet of water used in the production of $100,000 gross output of a given crop). The coefficient must be generated independently by the I-O analysis. Once the potential output is estimated, the I-O model can be used to examine the effects of the resource constraint on the economy. The beneficial effects of projects to alleviate the resource constraint can be evaluated.

If the resource constraint restricts output in only one sector, determining the impacts are fairly straightforward. There are several ways that the constrained output might be used in the economy. The simple case occurs when most of the output of the constrained sector would go directly to final demand. All the output cannot be available for final demand since the given sector often requires some additional production from within itself for any expansion of its output. To determine the amount available for final demand, divide the potential output by the sector's diagonal coefficient (where the subject sector is both selling and buying from itself) in the direct plus indirect coefficients table. This yields the amount of output available for final demand. Since the

23/ Except for errors introduced by rounding, this number is equivalent to the total of column 5, table 18.

diagonal coefficients are always greater than or equal to one, the amount available for final demand will be less than or equal to the potential output. The difference between output sold to final demand and total output is the sector's own output required as an input in the production of its total output and the output which it must sell to other expanding sectors.

When more than one sector is constrained by the limiting resource the diagonal coefficients and all the coefficients in the direct plus indirect coefficients table where each constrained sector intersects another constrained sector are used in estimating final demand. A smaller matrix is made of these coefficients, inverted, and premultiplied by the constrained outputs. The result is a vector of available final demands for each constrained sector. These final demands, when multiplied by the direct plus indirect coefficients, will show the outputs in every sector, the total output of the constrained sectors being exactly the same as determined earlier by the resource constraint. This procedure assumes that the constrained outputs will go largely to the final demands of the respective sectors.

The procedure for a single constrained sector can be applied to the hypothetical drainage component of Plan A. Suppose that, due to a water constraint, it is possible for the other-agriculture sector to increase output by only $40,000. The total impact of that $40,000 potential change in total output (not final demand) can be estimated with the use of direct plus indirect coefficients table, but only with some adjustments. Since the other-agriculture sector can only increase by $40,000, it is necessary to determine how much final demand would draw forth the full $40,000 of potential output. The interaction term of the direct plus indirect coefficients table indicates how much total gross output is required to support $1 of final demand for that sector. For the other-agriculture sector, $1.06 (table 7, column 2) of total gross output is required for $1 of final demand. Conversely, about $.94 sold to final demand will generate $1 total gross output. Since the feasible new gross output ($40,000) is known, dividing it by the interaction term, 1.061348, from table 7 gives the final demand, $37,688, implied by $40,000 gross output. The constrained increase in output ($40,000) has been converted to final demand ($37,688) and can be used along with the direct plus indirect coefficients table as explained previously. Total gross output of the economy would increase by $55,991 24/ due to the constrained total output increase of $40,000 in the other-agriculture sector. 25/

24/ 1.485655 (final demand multiplier) X $37,688 = $55,991.

25/ Another way of achieving the same result is to divide each coefficient in the relevant column of the direct plus indirect coefficients table by the appropriate interaction term (1.061348 in this example). The resulting column can then be multiplied by the $40,000 directly. The summation of the column provides a multiplier which can be used directly against gross output rather than final demand (7) (16), i.e., 1.485655/1.061348 = 1.399781. The procedure gives the same results since 1.399781 X $40,000 = $55,991.

## Display of Impacts of Plan A in Principles and Standards Accounts

Beneficial and adverse effects of the channel construction and drainage component of Plan A were evaluated in the previous sections using I-O analysis. The analysis of project effects was divided into three time periods: (1) project installation, (2) transition activities as local farmers prepared to take advantage of the project and began to realize some of its benefits, and (3) the time following complete project installation when all benefits attributable to the project were fully realized.

The regional increase in output, employment, and income impacts of the project for each time period have been displayed in the regional development account in Appendix C. 26/ In the social well-being account presented in Appendix C, employment and income effects within the region are further distributed among income and employment groups. Displays were not prepared for the environmental or the national economic development accounts. The national economic development account was not prepared because of problems of evaluating and identifying impact elements that represent tradeoffs among regions, which were not addressed in this report. The sum of the economic effects of Plan A across all regions would equal the values for the same effects shown in the national economic development account. Thus, in many cases, beneficial effects shown as accruing to the project region may be partially or largely offset by negative effects in the remainder of the Nation.

For the display of impacts in Appendix C, direct effects are defined to be changes in final demand. This definition is not consistent with standard I-O terminology of direct effects. In an I-O model, the direct effects refer to the direct purchases of the sector whose final demand changed. The initial change in the final demand of that sector might also be included as part of the direct effects.

## Use of I-O Models for Projections and Determining Planning Strategies

Many things that relate to an economy change over time. Technology and regional trade patterns are two items that can create problems for static I-O models. Since most I-O models are static, they reflect the technology and trade flows existing at the time the model was developed. Technology changes might alter the sectors from which a given industry makes its purchases as well as the amounts of those purchases. The more dynamic the industry the more likely it is that technology changes will affect the validity of the model.

One of the activities that faces most planning efforts is projecting plan impacts into the future. The I-O model can aid such an exercise if it is used properly. The analyst has several options for handling structural change.

---

26/ More detailed I-O models with sophisticated impact analysis routines may become feasible as more information is developed about the relationship between industry output and employment, income, various pollutants, etc. This I-O may eventually be useful in generating impact information for the environmental quality account and social well-being account as well as for the economic development accounts

Dynamic I-O models incorporate econometric relationships that adjust for future time periods. Another way of mitigating the problem is to run separate I-O models for different time periods with the direct coefficients altered to reflect technology changes. Sensitivity analysis can be performed on individual coefficients that seem likely to change. Some coefficients can change significantly without affecting the model results significantly. If the model is sensitive to changes in certain coefficients, the future value of those coefficients will merit special attention.

The effects of changing regional trade flows on a regional I-O model are much the same as changes in technology. If a particular region's economy becomes more highly developed through time, it is likely to depend less on imports than it did in the past. Use of a static I-O model prepared for an earlier period may then underestimate the direct and indirect effects of given sectors on the local economy. It could also be that an economy could become more dependent on the outside economy and thus the static I-O model would overestimate the effects. Correction of this problem could follow the same course as the technology problem. For either reason, changing technology or changing regional trade flows, one must use caution in drawing conclusions about future impacts. Nonrecognition of this problem could lead to some very misleading if not totally incorrect policy or plan prescriptions.

Improper implications can be drawn from I-O models and multipliers. For example, just because one sector has a higher multiplier than another does not mean that it is more important. A high multiplier merely indicates a high level of economic interdependence. The direct coefficients and the multipliers say nothing about the relative size one sector compared to another. However, information that must be assembled to arrive at the transactions table does tell a great deal about the size of sectors and their importance in the economy. This is the advantage of having a complete I-O model versus only multipliers. If an economy is dominated by one sector and that sector tends to be unstable the regional economy is likely to be unstable. Policy prescriptions then might include attempting to improve other sectors that do not have the instabilities of the dominating sector. Examination of the relative size of multipliers does provide an indication of which sectors might provide more total overall growth in the economy for given levels of final demand expansion. The degree to which final demand can be expanded must be considered also.

# CHAPTER VI. GENERAL APPLICATION OF I-O ANALYSIS AND ITS MULTIPLIERS

by John Wilkins

This chapter illustrates the use of I-O final demand multipliers in evaluating typical natural resource projects. All of the examples presented are hypothetical and have been developed to point out specific problems which occur with I-O analysis. Final demand multipliers, 27/ the most common multiplier generated from I-O models, show the total expansion of output in all industries as a result of $1 worth of goods or services delivered to final demand 28/ by a single industry in the model.

## Preparing Project and Program Benefit and Cost Estimates for Multiplier Analysis

Several cautions and procedures should be kept in mind before applying final demand multipliers or any I-O multiplier in project analysis.

(1) I-O and its final demand multipliers are applicable only to transactions which can be made through the market place. Increased livestock production or electricity use are examples of market transactions. Even though nonmarket benefits and costs are sometimes assigned dollar values in benefit-cost estimates, they should not be evaluated with multipliers. They create no actual dollar impacts in markets. Examples of nonmarket estimates are opportunity costs and esthetic benefits which may have been assigned a dollar value.

(2) Multipliers should be applied to gross changes in benefit and cost figures, not just to net figures. For example, the total sales value of an extra bushel of wheat, not just the net value over costs, causes indirect economic activity in other sectors of the economy. Table 19 shows that using net benefits underestimates indirect economic impacts. In this case, the $450,000 represents only the net income of increased crop output, whereas $1.75 million is the full sales value of increased crop production. Gross revenue is the proper variable to evaluate.

27/ Final demand multipliers will be referred to simply as multipliers.
28/ Demand in the I-O context is of two types. Final demand is final or terminal disappearance of goods or services in the form of exports, government, capital formation, or household consumption. Intermediate demand is goods or services purchased for further processing prior to sale to final demand.

Table 19--Estimation of indirect economic impacts, using net benefits and gross benefits

| I-O model sector | Net benefits: Change in final demand | Net benefits: Change in gross output | Gross benefits: Change in final demand | Gross benefits: Change in gross output |
|---|---|---|---|---|
| | 1,000 dollars | | | |
| Livestock | 1/ 450 | 10 | | 37 |
| Other-agriculture | | 478 | 1,750 | 1,859 |
| Agricultural services | | 46 | | 179 |
| Mining | | 1 | | 5 |
| Construction | | 6 | | 25 |
| Manufacturing-food | | 3 | | 10 |
| Manufacturing-other | | 30 | | 116 |
| Manufacturing-wood | | 3 | | 14 |
| Transportation-finance-insurance-real estate | | 41 | | 158 |
| Retail-wholesale | | 25 | | 99 |
| Services | | 25 | | 98 |
| Total | 450 | 668 | 1,750 | 2,600 |

1/ See item 12 of this section for procedures for reducing gross output to final demand.

(3) Project and program benefits and costs are both treated in the same manner in multiplier analysis. Just as an increase in crop production can bring on indirect economic activity in other sectors, so too can construction expenditures. Thus, the indirect effects of both benefits and costs can be treated as beneficial economic activity in the regional development account, following Principles and Standards, because both increase regional economic activity. Benefit-cost analysis seeks to classify money flows as adverse or beneficial. Multiplier analysis, however, deals with estimates of the indirect economic activity associated with those money flows.

(4) An expenditure, regardless of source, creates direct and indirect economic impacts in the evaluation area. If construction funds are obtained from out of the region under construction, they may be analyzed with multipliers with few adjustments. However, if local people tax themselves to supply construction funds (either in full or to match funds under a cost sharing plan) their spending in other areas should be reduced accordingly, and analyzed to obtain offsetting negative multiplier effects.

(5) Multipliers, like their parent I-O models are best used to analyze small changes in final demand. Large changes in final demand, such as those equal to half or more of sectoral gross output, are likely to change production technology and the input structure enough to change the multipliers.

(6) Production decreases or negative changes can also be used with multipliers and I-O. A production decrease times a multiplier provides an estimate of indirect negative effects.

(7) Multipliers show the indirect economic outputs from what are called backward linkages. That is, they show the inputs behind or supporting production of a unit of output prior to its entering final demand. Multipliers do not show foward linkages after production is complete. The indirect economic effects of an increase in crop production will show backward-linked impacts on the demand for fertilizer, machinery, labor, etc., but not forward-linked impacts (after the crop is sold) such as transportation, storage, processing, and retailing. Furthermore, multipliers and I-O will not show changes in the structure of the economy, such as diversification or externalities, as a result of a production change.

(8) It is important to choose the correct industry or sector in which to analyze the primary economic impact. To do so correctly requires a familiarity with I-O theory and with trade flows of the economy under construction. For example, there is usually no outdoor recreation sector or

multiplier in I-O models. Recreation expenditures are felt initially in trade and service sectors, reflecting purchases of food, licenses, gas or lodging. Increased crop production, if exported, would initially impact the economy in the crops sector. If processed locally, it would probably impact in a food processing sector. The analyst must consider each situation and decide upon the proper initial impact sector.

(9) A related matter is that of new or nonexistent sectors. If an undeveloped region under evaluation finds itself with a new steel plant, there will be no historical basis on which to use an existing regional multiplier for local impact estimates. In this case, a multiplier from some other region with a similar economic structure and having a steel plant of similar technology could be used. Along the same line, a dryland crops multiplier is not adequate for estimating the indirect economic impacts of crop production from a new irrigation project in the region. In the case of an I-O model, an irrigated crops sector could be added.

(10) Project costs and benefits are often composed of several items which can be analyzed using multipliers from several sectors if that level of detail is available. An irrigation project, for example, may entail construction costs evaluated using the construction multiplier; pumps using a machinery sector multiplier; self-propelled irrigation sprinkler systems using the farm machinery multiplier; and increased electricity use utilizing the electric utilities multipliers. The I-O model sector definitions and Standard Industrial Code (SIC) categories should be examined if there are questions with regard to proper sectors.

In table 20, a hypothetical project costing $25 million is analyzed for indirect effects, using a general or one sector approach on the left side of the table and a more detailed or four sector approach on the right side of the table. In this hypothetical case, impacts are greater using the one sector general approach. However, this will not always be the case. The detailed approach is better than the general one sector approach if the breakdown into components and sectors yields a more accurate picture of the initial distribution of costs and benefits than would existing row coefficients in a one sector approach. The detailed or multisector approach is probably superior to the single sector general approach because it permits an approach more tailored to the specific problem.

(11) Increased wholesale and retail sales are not generally valued at full sales value in I-O models. Rather a markup or sales margin value is used. This policy is in

Table 20--General one sector versus detailed multisector analysis of a project

| I-O model sector | One sector: Change in final demand | One sector: Change in gross output | Several sectors: Change in final demand | Several sectors: Change in gross output |
|---|---|---|---|---|
| | 1,000 dollars | | | |
| Livestock | | 14 | | 17 |
| Other-agriculture | | 57 | | 39 |
| Agricultural services | | 65 | | 35 |
| Mining | | 296 | | 84 |
| Construction | 25,000 | 25,104 | 6,000 | 6,187 |
| Manufacturing-food | | 38 | | 76 |
| Manufacturing-other | | 7,232 | | 3,598 |
| Manufacturing-wood | | 366 | 8,000 | 8,968 |
| Transportation-finance-insurance-real estate | | 2,201 | | 2,856 |
| Retail-wholesale | | 2,333 | 9,000 | 10,313 |
| Services | | 1,929 | 2,000 | 3,714 |
| Total | 25,000 | 39,635 | 25,000 | 35,887 |

accord with the national and most State I-O models. The markup represents the cost of selling the item, and is the difference between what the sales outlet pays for the item and what it sells it for. Further clarification on this point is found in a BAE publication (54):

> In the national input-output model, commodities do not flow through the trade sectors to final demand, even though much of the actual flow does follow this path. Instead, trade final demand is represented by the gross trade margin which is equal to the difference between sales and the cost of the goods. The goods themselves flow from the last manufacturing stage directly to final demand. This characteristic of the national input-output model (found also in many regional models) requires that trade final demand changes be transformed from a sales basis to a gross trade margin basis. A factor, based on national relationships, can be calculated to represent the ratio of gross trade margin to total sales. This gross trade-margin for 1967--the year of the national input-output model--is given by:
>
> $$\frac{\text{Total wholesale \& retail output}}{\text{Total wholesale \& retail sales}} = \frac{\$163,365,000}{\$767,690,360} = .21$$
>
> This means that the gross trade margin--the required final demand--is equal to 21 percent of the estimated change in sales by trade. The approximation of the gross trade margin, using national aggregate data, may be useful in circumstances where study economies do not permit a more detailed analysis. However, this measure has shortcomings: (1) it does not differentiate between types of retail and wholesale establishments, and (2) it does not take into account the potential regional impact associated with the production of local goods.

Therefore, when applying a multiplier to a wholesale or retail sales increase, reduce the sales increase to the markup before multiplying by the multiplier. Using the full sales value overstates impacts considerably.

Table 21 demonstrates the results of three methods of handling sales. Column 2 of the table shows output results when the full value of sales is entered as a trade final demand change. This demonstrates the overestimation of indirect output impacts.

Table 21--Indirect output impacts of increased sales valued at sales value and at mark-up

| I-O model sector | Full sales values: Change in final demand | Full sales values: Change in gross output | Mark-up of imported goods: Change in final demand | Mark-up of imported goods: Change in gross output | Mark-up of local goods: Change in final demand | Mark-up of local goods: Change in gross output |
|---|---|---|---|---|---|---|
| | 1,000 dollars | | | | | |
| Livestock | | 4 | | 1 | | 6 |
| Other-agriculture | | 6 | | 2 | | 28 |
| Agricultural services | | 4 | | 1 | | 11 |
| Mining | | 1 | | 0 | | 19 |
| Construction | | 52 | | 11 | | 51 |
| Manufacturing-food | | 26 | | 5 | | 19 |
| Manufacturing-other | | 315 | | 66 | 1/ 5,530 | 8,352 |
| Manufacturing-wood | | 4 | | 1 | | 24 |
| Transportation-finance-insurance-real estate | | 962 | | 202 | | 753 |
| Retail-wholesale | 7,000 | 7,165 | 2/ 1,470 | 1,505 | 2/ 1,470 | 1,790 |
| Services | | 570 | | 120 | | 461 |
| Total | 7,000 | 9,109 | 1,470 | 1,914 | 7,000 | 11,514 |

1/ Full sales value ($7,000) less mark-up ($1,470) = output of manufacturing (other) $5,530. Assumes no other primary effects.
2/ Mark-up of 0.21 (aggregate national mark-up) x $7,000 = $1,470.

The correct method of estimating the indirect output impacts of increased sales is shown in the columns 3 and 4, where only the markup is entered, a change in trade final demand. In this case, the goods sold are assumed to be imported from outside the region. Columns 5 and 6 assume that the goods sold in the trade sector are manufactured within the region. This is shown by the $5,530 in the manufacturing-other sector.

(12) A pertinent question is whether a change in the output of a sector should be considered (from an I-O view) as a change in gross output or as a change in final demand. 29/ The question arises because I-O responds to demand changes, but most resource development projects are oriented to increasing supply or output. The question is one of reconciling demand and supply. If the change is considered to be a change in gross output, then it must be reduced to a final demand level in order to multiply it by a final demand multiplier. Failure to reduce it results in an overstatement of indirect economic impacts. If the change in the benefit or cost is, indeed, a final demand change, then no reduction is necessary prior to multiplier analysis. It would appear the exogenous or demand changes from outside the area are final demand changes. On the other hand, if the change is an output or expenditure increase, it could be classed as either a final demand or a gross output change, but most likely is a gross output change.

Table 22 shows the effects of failing to reduce an output figure to final demand prior to I-O analysis. The manufacturing-wood sector is assumed to increase by $1 million gross output. On the right side of the table, it has been reduced to its proper final demand level, as shown in the footnote to table 4. Indirect impacts are overestimated by $144,400 when the gross output figure is used as if it were a change in final demand.

(13) It is not appropriate to do a multiplier analysis on project outlays for land. The case is similar to trade-in, second-hand goods. Ownership changes but no new production results. Changes in productivity of the land as a result of a use change are appropriate for multiplier analysis.

(14) The Principles and Standards list increased efficiency as a beneficial effect. Technical efficiency could be defined as producing a given quantity of output with fewer inputs, or as producing additional output with the same amount of inputs. Efficiency can be evaluated with I-O models by manually reducing appropriate technical coefficients to represent fewer

29/ Also, see Chapter V.

Table 22—Direct and indirect impact estimates from a change in gross output and from a change in final demand

| Sector | Change in gross output level | | Change at final demand level | |
|---|---|---|---|---|
| | Change in final demand | Change in gross output | Change in final demand | Change in gross output |
| | 1,000 dollars | | | |
| Livestock | | 0.3 | | 0.3 |
| Other-agriculture | | 1.1 | | 1.0 |
| Agricultural services | | 1.5 | | 1.3 |
| Mining | | 1.3 | | 1.2 |
| Construction | | 7.2 | | 6.5 |
| Manufacturing-food | | 1.1 | | 0.9 |
| Manufacturing-other | | 152.2 | | 137.2 |
| Manufacturing-wood | 1,000 | 1,109.2 | 1/ 901.5 | 1,000.0 |
| Transportation-finance-insurance-real estate | | 93.1 | | 83.9 |
| Retail-wholesale | | 57.6 | | 51.9 |
| Services | | 41.8 | | 37.7 |
| Total | 1,000 | 1,466.4 | 901.5 | 1,322.0 |

1/ $\frac{1,000,000}{1.109258}$ (direct-indirect coefficient manufacturing-wood sector) = \$901,503.527 - final demand.

inputs for a constant level of output. This could be carried out in I-O analysis utilizing "with" and "without" I-O models. The "without" model is the original model. The "with" model is the original after a technical coefficient or interindustry transaction has been decreased to reflect an efficiency change. After changing the coefficients, the model can be inverted to obtain new indirect plus direct coefficients and multipliers.

In table 23, columns 1 and 2 show the indirect effects of an increase in final demand in the manufacturing-other sector in a "without" matrix. Columns 3 and 4 show the indirect effects in the "with" matrix where purchases of the manufacturing-other sector from the manufacturing-wood sector were reduced to nearly zero, representing fewer inputs or an efficiency increase. In this case, a more efficient use of inputs set free $539,000 of inputs which could be used elsewhere in the economy. Efficiency reduces economic impacts if it is assumed that the inputs saved are not used elsewhere. Efficiency may reduce prices of production inputs as a result of decreased demand for the input. Evaluating efficiency in the absence of a "with" and "without" model or merely as a production change overstates the indirect impacts, because the technical coefficients assume a fixed relation between output and input mix.

(15) I-O models represent transactions for a 1-year period in time. Therefore, benefits and costs must be evaluated on a 1-year basis. Long-term cost and return streams can either be averaged or discounted at prevailing interest rates to an average annual basis before multiplier or I-O analysis. If a structure is to cost $60,000 and take 3 years to install, then the yearly cost is $20,000, or $22,498 if amortized at 6 1/8 percent interest for 3 years. An alternative procedure is to analyze costs or returns in a future year I-O model and then discount resulting indirect effects to present value. However, future yield or projected I-O models are not as reliable as recent I-O models. 30/

(16) One could estimate indirect economic effects in two kinds of time frames. Benefits and costs could be evaluated as they actually occur over time. During the construction period, only construction expenditures may be generating indirect effects. If the project were analyzed after construction was complete, only the benefits may be generating indirect effects. It is likely that benefits and costs will occur at different times. For example, a project may be in the construction stage for 3 years with no benefits accruing. On the fourth and following years, benefits may be coming forth and construction expenditures may have ceased.

30/ See the discussion of the time dimension of the evaluation problem in Chapter V.

Another view would be to look at costs and benefits from an average annual viewpoint over an evaluation period. Since this involves an interest rate and averages, it is a departure from real world money flows. Nevertheless, most agency economic analyses are on an average annual basis. This approach should be used with caution in I-O analysis.

Table 23—Estimation of the indirect effects of efficiency

| Sector | Original matrix | | Modified efficiency matrix | |
|---|---|---|---|---|
| | Change in final demand | Change in gross output | Change in final demand | Change in gross output |
| | 1,000 dollars | | | |
| Livestock | | 100 | | 100 |
| Other-agriculture | | 478 | | 477 |
| Agricultural services | | 178 | | 177 |
| Mining | | 342 | | 342 |
| Construction | | 728 | | 728 |
| Manufacturing-food | | 252 | | 251 |
| Manufacturing-other | 100,000 | 149,825 | 100,000 | 149,769 |
| Manufacturing-wood | | 424 | | 16 |
| Transportation-finance-insurance-real estate | | 9,640 | | 9,606 |
| Retail-wholesale | | 5,168 | | 5,146 |
| Services | | 6,181 | | 6,165 |
| Total | 100,000 | 173,316 | 100,000 | 127,777 |

The general rules for the use of I-O multipliers are: only goods and services sold in a market are appropriate for multiplier analysis; net values (except in sales) should not be used; all output values should be reduced to final demand; and a multisector approach is superior to a single sector approach.

## Multiplier Use in Functional Components

I-O models are more accurate than aggregate multipliers; however, multipliers are more readily available. Therefore, multipliers should be used when I-O models are not available, recognizing the preceding cautions. This section provides general guidance in the use of multipliers in several areas of water resource development or water derived services. All different situations concerning benefits and costs cannot be anticipated and explained, but an an attempt is made to discuss a variety of situations. Several hypothetical examples are presented. The final demand multipliers used in this section do not correspond to earlier chapters of the text.

### Irrigation

Costs. Costs of irrigation land development often include several activities--water storage and distribution facilities, brush clearing, leveling, drainage, pump or canal installation, and sprinkler pipe purchases. Construction costs are evaluated in the construction sector. If a farmer does land clearing, the cost may be evaluated in an agricultural sector. If construction companies clear land, the construction multiplier should be used to estimate impacts. Costs of these activities must be adjusted as described in the previous section, and then the separate components multiplied by the appropriate sectoral multipliers. Structure installation costs are usually a one time occurrence. Operation and maintenance costs continue through the project life.

Benefits. The estimated average annual value of increased crop production can usually be directly multiplied by the crop multiplier. However, it should be reduced to final demand first. Crop output generally begins to accrue after project construction is complete, and then levels off. This income stream can be evaluated, as it is expected to actually occur in a given year, or it can be averaged and discounted back to the present. Average annual costs and benefits must be based on the same interest rate and evaluation period.

Example. Assume an irrigation project is being built which involves construction of a dam, a reservoir on forested land, and a water distribution system. It also involves clearing rangeland for flood and sprinkler irrigation. The output of the project will be row crops to be processed locally and grain crops to be exported from the region.

Average annual costs are estimated at \$1.25 million. Average annual benefits are estimated to be \$1.7 million. Initiating multiplier analysis of the project requires that the costs and benefits be separated into components.

Annual costs may be broken down in a project report in a form such as the following:

| | |
|---|---|
| Dam, reservoir, and distribution system construction costs | $ 800,000 |
| Reservoir land acquisition costs | 50,000 |
| Operation and maintenance costs | 100,000 |
| Land clearing costs | 250,000 |
| Sprinkler pumps and pipes | 50,000 |
| | $1,250,000 |

Estimates of the indirect effects of each component might proceed as follows:

Construction costs:
$800,000 x 1.230 (construction final demand multiplier) = $984,000 (total change in output) resulting in $184,000 31/ of indirect output effects. This is the general approach to project evaluation as discussed earlier. A detailed approach would be better.

Reservoir land acquisition costs:
$50,000 not subject to multiplier evaluation. However, cutting and selling standing timber on the reservoir site has an estimated value of $5,000. $5,000 x 1.379 (logging contractor final demand multiplier) = $6,895, resulting in $1,895 indirect impacts.

Operation maintenance and repair costs:
Assume that half of these costs are for administration and half are in the form of maintenance construction. $50,000 x 1.270 (government final demand multiplier) = $63,500, resulting in $13,500 of indirect impacts. $50,000 x 1.391 (maintenance construction final demand multiplier) = $69,500, resulting in $19,550 of indirect impacts.

Land clearing costs:
Assume in this case that land is cleared by construction contractors and equipment, and that the overall construction sector multiplier is used. $250,000 x 1.230 (construction final demand multiplier) = $307,500, resulting in $57,500 of indirect impacts.

Sprinkler pumps and pipes costs:
Assume this equipment can be purchased locally. $50,000 x 1.240 (farm machinery final demand multiplier) = $62,000, resulting in $12,000 of indirect impacts.

Benefits:
The project involved irrigated crops on former rangeland. Range livestock production could then be assumed to decrease by $250,000 yearly. Decreased livestock sales of $250,000 x 1.671 (livestock final demand multiplier) = $417,750 which results in negative indirect impact or cost of $167,750.

31/ The change in final demand times the final demand multiplier equals the total change in output. Total change minus the change in final demand equals the indirect output effects.

A row crop production increase of $1 million might create a $1.5 million increase in the local food processing sector. $1.5 million x 1.601 (food processing final demand multiplier) = $2,401,500, resulting in $901,500 of indirect impacts. Chapter V offers a more detailed discussion of this technique.

The increase in grain production could create an increase of $700,000 in grain exported from the region. $700,000 x 1.555 (irrigated grain crops final demand multiplier) = $1,088,500, resulting in $388,500 of indirect impacts.

This example of multiplier analysis could be summarized as follows:

| | |
|---|---|
| Average annual costs | $1,250,000 |
| Average annual benefits | $1,700,000 |
| Net indirect output | $1,410,695 |

Drainage 32/

Costs. The recommendations and example pertaining to irrigation are generally applicable to drainage.

Benefits. Drainage benefits would be treated much like irrigation benefits. If land use changes are involved, production losses as well as production gains from the change should be evaluated.

Land Treatment

Costs. Costs are handled much like irrigation and drainage costs. If a government agency carries out the land treatment itself as a part of its normal operations, the costs could be evaluated with a government multiplier, if available. If not, the costs could be broken into components and evaluated with separate sectoral multipliers.

Benefits. Land treatment benefits could be in the form of increased crop or livestock output because of increased water yield, or in the form of nonmarket benefits such as reduced sedimentation damage. Increased farm output is evaluated like the benefits of irrigation. However, reduced sedimentation is not sold in the market. Such benefits should not, in most cases, be evaluated using I-O multipliers. This is not to say that there are no benefits. If the analyst can estimate the forward linkages of increased water yield or reduced sedimentation, he may be able then to identify and analyze the market effect, if any.

32/ See the detailed example in Chapter V of an evaluation of a drainage project.

Flood Damage Reduction

Costs. Installing flood damage reduction structures, in a sense, condenses the annual costs of several years' flooding into the construction period. Therefore, one could argue that the flood damage reduction measured may change the timing but not the magnitude of economic impacts. Structure construction costs likely impact primarily on the construction sector. Yearly clean up costs should be deducted from average annual costs prior to applying a multiplier.

Benefits. Benefits may occur as market or nonmarket production increases. Some market benefits may, of course, be the result of land use changes such as more intensive agriculture.

Example. One might view a flood damage reduction situation for multiplier analysis as follows. Average annual damages are $35,000--$20,000 to farmland and $15,000 to streets, roads, bridges, and buildings. Structural measures to prevent flood damage may cost $200,000 and take 2 years to install.

Multiplier analysis could proceed by first estimating the indirect effects of structure costs during the 2-year construction period.

$$\frac{\$200,000}{2 \text{ years}} = \frac{\$100,000}{1 \text{ year}}$$

$100,000 x 1.216 (construction final demand multiplier) = $121,600, resulting in $21,600 of indirect impacts.

Since this example involves fairly short time lags, the costs and benefits are not considered on a discounted average annual basis.

The indirect effects of the yearly clean up, which will be a decrease in economic activity after installation of flood damage reduction structures, should be estimated. -$15,000 x 1.215 (construction final demand multiplier) = -$18,225, resulting in $3,225 of negative indirect impacts. If the local government unit which administered the project spent the money the next year on other public works, the negative effect would be offset.

The $20,000 yearly damage to farmland is assumed to be in the form of decreased crop production. Therefore, after the structures are installed, it becomes a yearly $20,000 benefit plus its indirect effects. $20,000 x 1.073 (crop final demand multiplier) = $21,460, resulting in indirect benefits of $1,460. Benefits and costs, in this case, may seem disproportionate, but one should keep in mind that there is no attempt here to use discounted average annual figures nor to estimate a benefit-cost ratio. Rather, the objective is to estimate indirect effects, viewing benefits and costs as they may actually occur over time. This hypothetical project, evaluated over a 10 or 20-year evaluation period, may yield a favorable benefit-cost ratio.

## Outdoor Recreation

Costs. The costs of construction of outdoor recreation facilities are usually initiated in the construction sector. By observing the general cautions specified elsewhere in this report, costs are usually easy to evaluate with multipliers.

Benefits. Outdoor recreation benefits in a large area such as a State or region may not be new infusions of economic activity, but shifts from an existing activity to a new one. In this case it is seldom justified to claim and evaluate benefits in the national economic development account. If the benefit is new sales activity and expenditures, however, then the markup can be valued with multipliers to estimate indirect impacts for the national economic development accounts. In a small area such as a few rural counties, an outdoor recreation project may attract outsiders or attract local people to the new facility. In this case, benefits can be claimed in the regional development account.

## Fish and Wildlife

Costs. Costs in the form of structures are evaluated as construction costs, after making proper adjustments. Land use changes may involve positive or negative production changes. The sales value of the land transfers is not appropriate for multiplier analyses.

Benefits. Benefits felt in the market are appropriate for multiplier evaluation. Nonmarket benefits are not appropriate unless special multipliers have been developed. Benefits may be in the form of increased commercial fish catch (market) or in the form of increased sport fish catch and hunter success (nonmarket). However, sport fishing and hunting equipment purchases may be evaluated as service and sales values, like outdoor recreation.

## Forestry

Costs. The forestry sector must be differentiated from the lumber and wood products industry. Is it a forestry firm, a lumber and wood products firm, or government agency which will incur forest management costs such as timber stand thinning? The I-O model sector definitions and SIC manual, combined with the analyst's judgment, can assist in proper initial sector identification.

Benefits. Benefits of forest practices are usually long run, and occur in lumps. For example, reseeding a cutover area now could yield Christmas trees in 10 years, pole timber in 30 years, and saw timber in 80 years, each of which is in a separate SIC category. These lumps of benefits can be discounted back to present average annual value and multiplied by appropriate sector multipliers or input into the proper sectors of an I-O model.

## Environmental Quality

Costs. Costs may be in the form of production losses or facility construction costs. Production losses should be in the form of market products or services to be appropriate for multiplier evaluation. Construction costs should be evaluated as described in previous sections.

Benefits. Many environmental quality benefits may be of the nonmarket or "difficult to value" type. Each case should be considered on its own merits, in light of the cautions and limitations previously discussed.

Example: This example may demonstrate techniques in the areas of environmental quality, water quality, and municipal and industrial water supply. Suppose a council of governments in a drainage basin establishes the goal of improving the quality of the water in its main river. This will be accomplished by changing farming from cultivated crops to pasture on high sediment producing farmlands, installing additional municipal sewage treatment facilities, and designating the river banks as green belts. The physical effects of the project are, in addition to improving water quality, to change the composition of farm output, improve the commercial and sport fish catch, increase outdoor recreation along the river, and reduce the need for muninicipal and industrial treatment downstream.

The first step is to transform these physical effects into hypothetical economic effects amenable to multiplier evaluation. The demonstration is simplified by assuming that many of the problems discussed in preceeding sections will not occur.

Changing composition of farm output:

Decrease in row crop sales, $10,000 x 1.345 (crops final demand multiplier) = $13,450, resulting in negative indirect effects of $3,450.

Increase in livestock sales, $5,000 x 1.302 (livestock final demand multiplier) = $6,510, resulting in indirect impacts of $1,510.

Improved fish catch:

Increased value of commercial catch $1,500 = 1.571 (fishery final demand multiplier) = $2,356, resulting in an indirect impact of $856 increased value of sport catch. A shift from stream and lake fishing to river fishing is assumed. No substantial change in outdoor recreation expenditures occurs.

Improved outdoor recreation along the river:

Increases of river-related recreation are assumed offset by decreases in other forms of recreation. Hence, there is no measurable economic shift.

Reduced need for municipal and industrial water treatment downstream:

This benefit could be viewed as an efficiency increase in the water utilities sector. If the efficiency takes the form of reduced costs and is passed on to consumers, then the value of output of the utilities sector is decreased which is offset by an increase in consumer income.

-$1,000 x 1.712 (water utilities final demand multiplier) = -$1,712 (reduced total change in output), resulting in $712 of negative indirect impacts.

+$1,000 x 1.750 (household sector FD multiplier) = $1,750 change in output, resulting in $750 of positive indirect impacts.

If the water utility does not pass the efficiency on to its consumers, but just decreases its use of some input such as chemicals, then the decrease can be analyzed with the chemical sector multiplier.

-$500 x 1.129 (chemical final demand multiplier) = -$564 reduced change in total output or $64 in negative indirect effects.

Water multipliers or coefficients may be useful in environmental quality analysis. Estimates of sectoral water use changes could be made once water use is related to gross output levels.

## Municipal and Industrial Water Supply

Costs. Costs will usually be one time installation costs initiated in the construction sector. Pumps, filters, pipes, etc., are usually evaluated with some manufacturing multiplier. Operation and maintenance costs continue over time.

Benefits. The benefits of municipal and industrial water supply could be in the form of increased water quality or in the form of a more reliable supply system. Depending on whether the output of public water utilities is market or nonmarket, the benefit, if measurable, could be expressed as a change in gross output of the water utilities sector or as a coefficient change to represent an efficiency change. Multiplying an output change by the multiplier would show the input impacts or backward linkages in support of the water utilities sector. Response in output or greater efficiency (forward linkages) in water using sectors would not be shown under these circumstances. However, they could be evaluated, if measurable, by increasing the outputs of major water users. This may assume that water is the primary constraint on output, an assumption which may be poorly founded in many cases.

## Water Quality

Costs. Costs may be in the form of construction and maintenance for water treatment facilities. It is usually fairly simple to estimate the indirect effects on the economy. Previously mentioned warnings and adjustments should be observed.

Benefits. The difficulties of measurement and evaluation pertaining to municipal and industrial water benefits are applicable here, also. In addition, benefits may occur in the form of improved fish and wildlife or outdoor recreation opportunities. Such benefits should be evaluated as described earlier.

## Electric Power

Costs. Multiplier evaluation of costs is fairly straightforward. Costs can be amortized over the construction period at the proper interest rate prior to multiplier or I-O evaluation. However, the cost of hydroelectric or thermal electric plants is often so large that existing interindustry relations upon which a multiplier was originally determined are distorted. The existing multiplier may therefore no longer be an effective representation of indirect economic impacts. A multiplier from some other similar region for a similar electric power project could be used. The regional source of sophisticated machinery is also an important consideration.

Benefits. Electric power benefit evaluation presents the same problems as does municipal and industrial water supply benefit evaluation. Electric utility production is valued in the national I-O model as the operating revenue or sum of charges made by the utility to its customers. There is still the problem of how to evaluate the increased production once it has had a dollar value estimated. If it is considered to be an increase in output of the electric utilities sector, then only the multiplier effects of increased inputs to the sector, or backward linkages, will be estimated. The additional output, or forward linkages, it permits in other sectors as they respond to increased availability of electricity would not show, but could be evaluated if it were possible to estimate the output responses. It would not be valid to assume that all sectors would increase output in response to additional electric power availability. If the analyst has good evidence that some industry such as aluminum production would markedly increase output in response to additional electric power, then it would be acceptable to apply a multiplier to the aluminum sector to estimate indirect economic effects. Increased domestic welfare from electricity is generally not amenable to multiplier analysis.

## Navigation

Costs. Construction costs for navigation improvements are apt to be large and, therefore, subject to limitations like those for electric power facilities. Such projects can change the economic structure of the economy and the multiplier.

Benefits. Navigation benefits are likely to be in the form of reduced transportation costs, an efficiency increase. As such, they may be difficult to evaluate with multipliers. It is important to keep in mind that an increase in water borne commerce may be offset by a decrease in nonwater commerce. There may be little or no gain, merely a change in transportation mode. In such a case, the output of water borne transportation could be increased and evaluated for indirect effects, and that of truck and rail transportation decreased and the indirect effects estimated.

## Other Applications of Multipliers and Coefficients

It is useful, in some cases, to develop sectoral coefficients reflecting the relationship between sectoral gross outputs and an input or resource such as water, capital, land, labor, energy, or pollution, which are usually not directly measured in an I-O model. Energy and pollution coefficients could have special significance in the environmental quality account of Principles and Standards accounting. These coefficients 33/ (sometimes called resource coefficients) are expressed in terms such as acre-feet of water per million dollars of gross output, as employees per million dollars of output, or as energy equivalents per million dollars of output.

A further extension of I-O model and I-O multipliers could be in the form of simulation and linking with other economic and physical models. For example, a river basin can be simulated with linked models representing climate, stream flow, withdrawals, return flows, optimum water use patterns and levels, crop outputs, crop values, and multiplier derived economic impacts. The output of efficiency models such as linear programming can be input to I-O models, or analyzed with multipliers.

Economic analysis, no matter how carefully done, is only one input into the natural resource and regional decisionmaking process. There are also legal, engineering, political, and ecological factors to consider. After economic impacts have been estimated, they, along with other factors, must still be evaluated as to whether or not they meet the overall objectives of planning. The shortcomings of economic evaluation must be kept in mind. Economic models are simulations, not duplicates of the real world. Therefore, model impacts may differ from real world impacts. For example, I-O and multiplier techniques assume a linear and unlimited supply of inputs to production without substitution. This is not the case in the real world. Does a region actually have the development potential and the resource inputs a linear I-O model assumes? Furthermore, I-O model impacts do not deal with the question of changing concentration or diversification of industry, which may be a regional development concern.

33/ See the brief discussion of resource coefficients in Chapter V.

# CHAPTER VII. CONCLUSIONS AND RECOMMENDATIONS

by Robert McKusick and Linda Zygadlo

## Conclusions

### Regional Development

(1) Regional development should be included as an optional planning objective in the WRC Principles and Standards along with national economic development and environmental quality. WRC and the Office of Management and Budget should recognize and make provisions for the fact that most States, regions and counties are interested in local socioeconomic evaluation and impacts.

(2) If regional development is included as a planning objective, impacts of alternative regional development plans on national economic development efficiency should be displayed so that local people and regional decisionmakers can compare costs, benefits, and other regional and environmental tradeoffs involved in selecting and implementing a plan emphasizing regional development.

(3) Regional studies should recognize the distinction between growth and development. Development is much broader than the economic characteristics of growth. Regional preferences, goals, and plans have to be determined and evaluated with respect to growth; development; existing resource base and industry mix; overall economic base; current and potential production of goods and services; demand for regional output; internal economic structural changes; sector expansion; regional boundaries; direct and secondary economic impacts on employment, income, and output; and intraregional and interregional commodity and factor distribution.

### Principles and Standards

(4) The Principles and Standards and the USDA Guidelines should include more precise descriptions of externalities. Whether an impact is considered internal or external depends on the problem definition and study area boundaries. Measurable externalities can be expressed in both monetary and nonmonetary values; however, some externalities are not measurable. Terms such as secondary output effects, indirect employment effects, and other more precise terms should be used in appropriate context. Categorizing these impacts under the vague term externalities leads to confusion and inconsistency in application.

(5) There is a need to develop applied examples for secondary effects which should lead to a more consistent application of the Principles and Standards. The application of I-O methods to develop applied examples was a major purpose

of this study. This report should be used in conjunction with the WRC Guideline 5 Regional Multiplier approach to give direction and caution in the use of multipliers.

(6) Information included in the regional development account should not be limited to a regional account duplicating the type of information in national economic development account. While the national economic development account focuses entirely on the national economic impacts of plans, the regional development account has a much broader base of information, ranging from economic to demographic and environmental impacts.

## I-O Analysis

(7) Since I-O is an important analytical approach used to determine regional development impacts and the BEA multipliers (60) are recommended by the WRC to be used nationwide, a special effort to educate practitioners in the application and use of I-O and multipliers should be made. The possibility for misapplication of I-O techniques is great.

(8) I-O models have advantages over the use of multipliers for detailed project and program evaluation and plan formulation. They enhance a researcher's analytical capacity, particularly the ability to develop and evaluate regional development strategies. Also, the techniques for estimating I-O tables for small areas at a reasonable cost are very promising.

(9) Extreme care should be used in applying I-O multipliers in isolation from the models from which they were derived. In particular, interregional flows (import-export balances) and other leakages out of the region can bias the multiplier approach. Assumptions and limitations of both approaches (table vs. multipliers) have to be considered before impacts can be properly estimated and interpreted. Tests should be conducted to compare broad geographical or sectoral multipliers to more specific regional multipliers.

## Regional Development, Principles and Standards, and I-O Analysis

(10) Conventional I-O techniques can be used to study regional development aspects of resource plans. However, meaningful application depends on: (a) reliable estimates of structural relationships among sectors of an economy, and (b) a careful study of direct project and program effects and conversion of these effects into final demand change on an industry-by-industry basis.

(11) I-O is not a cure-all for planners' problems with respect to regional development and secondary economic effects. Other studies and variables are required to handle the development aspects of a plan. I-O results relate to growth (i.e., regional economic movements in such aggregates as gross sales, household income, or employment).

Program and Project Evaluation

(12) A familiarity with regional commodity flows and economic theory is necessary in multiplier and I-O application to minimize misuse of the technique.

(13) Prior to multiplier or I-O analysis, appropriate adjustments must be made to benefit-cost estimates.

(14) All output changes must be reduced to final demand levels prior to I-O or multiplier analysis.

(15) Multiplier analysis provides only aggregate effects, whereas the use of an I-O model identifies sectoral changes.

## Recommendations for Future Research

(1) There is a need to determine how the impacts of plans developed using alternative objectives of national economic development, environmental quality and regional development would differ. Presently, the range of impacts on regional resource allocation and problem solution under these different objectives is unknown. Questions need to be answered concerning how the three types of plans might vary in a region with a highly concentrated economic base, a region of high export leakages, or in a region where industries are reduced or removed, and how alternative plans might result in different trade patterns.

(2) There is a need to strengthen and/or estimate some of the limiting assumptions and data weaknesses underlying I-O models:

(a) The relationship between the stability of regional models and the relative volume of imports and exports needs to be examined.

(b) Additional research is needed to lessen the disaggregation problems which prevent a higher degree of industry detail.

(c) Methods to relate final demand estimates to natural resource development, conservation, and management need to be improved.

(d) Methods to estimate more reliable technical coefficients at the regional level need to be developed.

(e) Conflicts between researchers concerning the elements included in the household income row and column need to be resolved.

(3) I-O models should continue to be expanded into other areas such as energy, capital, and pollution. Better estimates are needed of these coefficients associated with changes in current levels of industry output. This would involve close cooperation with physical and biological scientists. Of major importance are the effects on an economy when a new sector is added or an existing sector is changed or deleted due to such things as an energy crisis and pollution abatement control.

(4) Work should continue to improve: (a) nonsurvey techniques to develop small area models from national and regional models, and (b) national interregional models to link existing regional models to account for export/import flows and leakages out of small areas. Also, additional model extensions need to consider (a) the implication of discounting and other techniques to allow for the passage of time, (b) aggregation and size of region as related to multiplier stability, (c) supply and/or demand constrained models, and (d) distributional aspects of regional plans and the implications for cost sharing.

## BIBLIOGRAPHY


(1) Alexander, John W. The Economic Life of Oshkosh. Part I. Madison: Univ. Wisc., 1952.

(2) Barkley, Paul W. "The Economic Analysis of Small Areas: Intellectual Poverty Within Intellectual Plenty." In: Community and Human Resource Development in the West. Rpt No. 1. San Francisco: Western Agricultural Economics Research Council, 1971.

(3) Baumol, W. J. Welfare Economics and the Theory of the State. 2nd ed. Cambridge: Harvard Univ. Press, 1965.

(4) Bell, John F. A History of Economic Thought. New York: Ronald Press, 1953.

(5) Chiou-Shuang Yan. Introduction to Input-Output Economics. New York: Holt, Rinehart, and Winston, Inc., 1969.

(6) Ciriacy-Wantrop, S. V. "Benefit-Costs Analysis and Public Resource Development." In: Smith and Castle (eds.), Economics and Public Policy in Water Resource Development. Ames: Iowa State Univ. Press, 1964.

(7) Clark, Richard T., Robert B. Fletcher and Harley J. McKinney. The Star Valley Economy - An Interindustry Analysis. RJ85. Univ. Wyoming, Nov. 1974.

(8) Detroit City Plan Commission. Economic Base of Detroit. Detroit: 1944.

(9) Dorfman, Robert, Paul A. Samuelson and Robert M. Solon. Linear Programming and Economic Analysis. New York: McGraw-Hill, 1958.

(10) Edwards, Clark, Robert Coltrane and Stan Daberkow. Regional Variations in Economic Growth and Development--With Emphasis on Rural Areas. AERS 205, U.S. Department of Agriculture, Economic Research Service. May 1971.

(11) Federal Register. Water Resources Council, Water and Related Land Resources, Establishment of Principles and Standards for Planning. Wash., D.C.: Sept. 10, 1973.

(12) Fisher, Joseph L. "Concepts in Regional Economic Development Programs." Regional Sciences Association Papers and Proceedings, 1955.

(13) Fox, Karl A. "The Major Problem of Rural Society." Paper presented at the Third Annual Farm Policy Review Conference, Ames: Iowa, Dec. 18, 1962.

(14) Gittinger, J. P. Economic Analysis of Agricultural Projects. Baltimore: Johns Hopkins Univ. Press., 1972.

(15) Glasson, John. An Introduction to Regional Planning: Concepts, Theory, and Practice. London: Hutchinson Educational Ltd., 1974.

(16) Grubb, Herbert W. The Structure of the Texas Economy. Austin: Office of the Governor, March 1973.

(17) Haveman, R. H. "Evaluating Public Expenditures Under Conditions of Unemployment." In: Haveman and Margolis (eds.), Public Expenditures and Policy Analysis. Chicago: Markham Publishing Co., 1970.

(18) Haveman, R. H. and J. V. Krutilla. Unemployment, Idle Capacity, and the Evaluation of Public Expenditures. Baltimore: Johns Hopkins Univ. Press, 1968.

(19) Hirsch, Werner Z. "Interindustry Relation of a Metropolitan Area." Review of Economics and Statistics. XLI (Nov. 1959).

(20) Holmes, B. H. A History of Federal Water Resources Programs, 1800-1960. MP-1233, Econ. Res. Serv., U.S. Dept. Agr., 1972.

(21) Homer Hoyt Associates. Economics Survey of the Land Uses of Arlington County, Virginia. Sept. 1951.

(22) Hoover, Edgar M. The Location of Economic Activity. New York, McGraw-Hill, 1948.

(23) Hoover, Edgar M. "Some Old and New Issues in Regional Development." In: Regional Economic Development in the United States, U.S. Dept. Commerce, Econ. Dev. Adm. Oct. 1967.

(24) Isard, Walter. Methods of Regional Analysis: An Introduction to Regional Science, Cambridge, Mass.: MIT Press, 1960.

(25) Jansma, J. D. "Measuring the Impact of Natural Resource Investments on Employment, Income, and Economic Structure." Southern Cooperative Series, Bulletin 212, University of Florida, Gainesville, Florida, Oct. 1976.

(26) Kalter, R. R., et al. "Criteria for Federal Evaluation of Resource Investments." Ithaca: Cornell Univ. Aug. 1969.

(27) Keynes, John Maynard. The General Theory of Employment, Interest and Money. New York: Harcourt, Brace and World, Inc., 1964.

(28) Knetsch, J. L., et al. "Federal Natural Resources Development: Basic Issues in Benefit and Cost Measurement." Wash., D.C.: Natural Resources Policy Center, George Washington Univ., May 1969.

(29) Landgren, N. E. "Principles and Standards for Planning Water and Related Land Resources: Likely Impacts on Future Developments." Paper presented at the Great Plains Resource Economics Committee Seminar on Conflicts and Issues in Water Quality and Use, Denver: Apr. 7-8, 1976.

(30) Leontief, Wassily. "Quantitative Input-Output Relations in the Economic System of the United States." Review of Economics and Statistics. XVIII, (Aug. 1936).

(31) Leven, Charles L., John B. Legler, and Perry Shapiro. An Analytical Framework for Regional Development Policy. Cambridge, Mass.: MIT Press. 1970.

(32) Leven, Charles L. "The Economic Base and Regional Growth." In: Research and Education for Regional and Area Development. Ames: Iowa State Univ. Press, 1966.

(33) Leven, Charles L. "Establishing Goals for Regional Economic Development." In: R. P. Misra (ed.), Regional Planning Concepts, Techniques, Policies, and Case Studies. Prasaranga, India: Univ. Mysore, 1969.

(34) Leven, Charles L. "Theories of Regional Growth." In: Problems of Chronically Depressed Rural Areas. North Carolina Policy Series, Raleigh: N. Carolina Univ., 1965.

(35) Miernyk, William H. The Elements of Input-Output Analysis. New York: Random House, 1967.

(36) Mishan, E. J. Cost-Benefit Analysis: An Introduction. New York: Praeger, 1971.

(37) Misra, R. P. "On the Concept of Regional and Regional Planning." In: R. P. Misra (ed.), Regional Planning Concepts, Techniques, Policies, and Case Studies. Prasaranga, India: Univ. Mysore, 1969.

(38) Moore, Frederick T. and James W. Peterson. "Regional Analysis: An Interindustry Model for the State of Utah." Review of Economics and Statistics. XXXVII (Nov. 1955).

(39) North, Douglas C. "Exports and Regional Economic Growth: Reply." In: Regional Development and Planning. John Friedman and William Alonso, (eds.), Cambridge, Mass.: MIT Press, 1964.

(40) North, Douglas C. "Location Theory and Regional Economic Growth." In: Regional Development and Planning. John Friedman and William Alonso, (eds.), Cambridge, Mass.: MIT Press, 1964.

(41) Palmer, Charles and Ross Layton. "A User's Guide for Regional Input-Output Analysis." (Unpublished paper prepared for Econ. Res. Serv., U.S. Dept. of Agr., East Lansing, Mich.), 1973.

(42) Perloff, Harvey S., Edgar S. Dunn, Jr., Eric E. Lampard and Richard F. Muth. Regions, Resources, and Economic Growth. Lincoln: Univ. Neb. Press. 1960.

(43) Pfouts, Ralph W., (ed.). The Techniques of Urban Economic Analysis. Trenton, N.J.: Chander-Davis, 1960.

(44) Prest, A. R. and R. Turvey. "Cost-Benefit Analysis: A Survey." In: American Economic Association and Royal Economic Society, Surveys of Economic Theory: III. New York: St. Martin's Press, 1966. pp. 155-207.

(45) Richardson, Harry W. Input-Output and Regional Economics. Trowbridge, Great Britain: Redwood Press Limited, 1972.

(46) Schaffer, William A. and Kong Chu. "Non Survey Techniques for Constructing Regional Inter-Industry Models." Papers of the Regional Science Association, XXIII, 1969. pp. 89-92.

(47) Stipe, Sterling H., Jr. " A Proposal and Evaluation of a Regional Input-Output Modeling System." Unpublished Ph. D. dissertation, Mich. State Univ., 1975.

(48) Tiebout, Charles M. The Community Economic Base Study. Supplementary Paper 16. New York: Committee for Economic Development, 1962.

(49) Tiebout, Charles M. "Exports and Regional Economic Growth." In: Regional Development and Planning. John Friedman and William Alonso, (eds.), Cambridge, Mass.: MIT Press, 1964.

(50) United Nations. Problems of Input-Output Tables and Analysis. New York: 1966.

(51) U.S. Department of Agriculture, Economic Research Service. Rural People in the American Economy. AER-191, 1966.

(52) U.S. Department of Agriculture, Economic Research Service. Secondary Impacts of Public Investment in Natural Resources. MP-1177, Aug. 1970.

(53) U.S. Department of Agriculture. USDA Procedures for Planning Water and Related Land Resources. March 1974.

(54) U.S. Department of Commerce, Bureau of Economic Analysis. Industry-Specific Gross Output Multipliers for BEA Economic Areas. Dec. 1976.

(55) U.S. Department of Labor, Bureau of Labor Statistics. General Explanations of the 200 Sector Tables: The 1947 Interindustry Relations Study. BLS Rpt. 33. June 1953.

(56) Vlachos, Evan, et al. Social Impact Assessment: An Overview. A Report submitted to the U.S. Army Engineer Institute for Water Resources, Dec. 1975.

(57) Water Resources Council. Section 80 Study. Wash., D.C.: Nov. 1975.

(58) Water Resources Council. Principles for Planning Water and Land Resources. Wash., D.C.: 1970.

(59) Water Resources Council. Standards for Planning Water and Land Resources. Wash., D.C.: 1970.

(60) Water Resources Council. Guideline 5 Regional Multipliers. Wash., D.C.: Jan. 1977.

## APPENDIX A: GLOSSARY OF TERMS

by Clifford Jones, and Sterling Stipe

### I-O Definitions

When working with a particular I-O model it is important to become familiar with the conventions and definitions of that model. For example, the I-O model developed by BEA entitled, The Input-Output Structures of the United States Economy for the years 1947, 1958, 1963, and 1967 has an excellent set of descriptive materials describing the models developed by BEA over the past 30 years. This material is useful to the analyst who uses the above models. Since the BEA models serve as basic data sources for many other I-O models, especially State and regional models, one should become familiar with their characteristics. A good starting point for this is to review: Definitions and Conventions of the 1963 Input-Output Tables, Office of Business Economics, U.S. Department of Commerce, November 1970.

Aggregation. Combining business firms or economic activities of an economy into I-O sectors (or combining sectors within an I-O model, thereby reducing the number of sectors or size of the model).

Direct coefficients. See technical coefficients.

Direct employment change. The change in employment of a sector in response to a change in final demand for its output (the direct employment coefficient times a change in final demand).

Direct employment coefficient. Total employment of a sector divided by its total output.

Direct income change. The change in income payments to households in response to a change in final demand (the direct income coefficient times a change in final demand).

Direct income coefficient. Total income payments by a sector divided by its total output.

Direct plus indirect coefficients. Used interchangeably with total requirements and inverse coefficients. Each coefficient in a direct plus indirect coefficients matrix denotes the total output its sector must produce in response to a $1 change in final demand of a given sector. This matrix may also be identified as the $(I-A)^{-1}$, the inverse, the Leontief inverse, or the total requirements matrix. In an I-O model (if not transposed), the direct plus indirect requirements matrix, or the total requirements matrix, shows the total output required by the economy (all other sectors) from the row sector per dollar of delivery to final demand by the column sector.

Direct requirements. Used interchangeably with technical coefficients.

Disaggregation. Dividing sectors of an economy (or an existing I-O model) into smaller or more detailed groups, thereby increasing the number of sectors or size of the I-O model.

Employment multiplier. An estimate of the total employment generated in the economy per a one unit change in employment in a particular sector of the model. Type I accounts for only direct and indirect effects and the Type II employment multiplier includes the induced effects. See income multiplier for a description of Type I and Type II multipliers.

Endogenous variables. Those elements in an I-O model whose value is determined by the model, the dependent variables. The processing sector.

Exogenous variables. Those elements in an I-O model whose value must be specified independently, the final demand and payments sectors.

Exports. Goods and services produced within the area being modeled and sold to consumers outside the area. Exports are always considered part of final demand even if the goods exported are used in the processing sector of the new region.

Final demand. That part of an I-O model transactions table containing sectors which represent final or terminal consumers (in contrast to intermediate demand) of the output produced by the local economy or modeled economy. Purchasers of the processing sectors' output.

Final demand is the exogenous sector which determines the level of output of the I-O model's economy since changes in final demand are transmitted throughout the rest of the transactions tables. Final demand includes: personal consumption expenditures, gross private capital formation, inventory accumulation, and exports. Generally, government purchases are also included in final demand, however, some regional models include local government expenditures as part of the processing sector. In I-O models closed with respect to households, personal consumption expenditures by households within the economic area of the model are not part of the final demand.

Sales to final demand represent final sales by processing sectors in that this output does not reenter the production process of the model economy. Changes in sales to final demand are multiplied by I-O sector multipliers and coefficients to estimate changes in the model economy's level of output, employment, and income.

Final demand multipliers. The sum of the column entries in the direct plus indirect coefficients matrix, or total requirements matrix, of an I-O model. The sum for each column is that column sector's final demand multiplier. It denotes the value of total output that all sectors of the economy must collectively produce per dollar of output sold to final demand by the column sector. Final demand multipliers are also frequently referred to as gross output or output multipliers. The final demand multipliers discussed in this report coincide with the total gross output multipliers used by BEA.

Final output. See final demand.

Flow table. See transactions table.

Gross output multipliers (also output or total gross output multiplier). Used to describe two very different types of I-O multipliers. It is frequently used to describe what this report identifies as a final demand multiplier, a multiplier multiplied by final demand to determine a new level of gross output.

$(I-A)^{-1}$ matrix. See direct plus indirect coefficients.

Imports. Goods and services obtained from outside the area of the I-O model. They may be intermediate inputs of the processing sectors or direct purchases by final demand sectors, or imported value added inputs.

Income multiplier. Shows the amount of income generated in the economy per dollar of change in income payments of a given sector. There are two kinds: Type I and Type II.

The Type I income multiplier estimates the direct and indirect change in household income in the economy of the model per dollar change in direct income payments to households. This multiplier is also called the simple income multiplier. The Type I multiplier is computed from an I-O model with households exogenous.

The Type II income multiplier estimates the direct, indirect, and induced change in household income per dollar change in the direct income payments to households. It takes into account the induced effect of consumer spending on household income, in addition to the direct and indirect effects of changes in output on household income. Computed from an I-O model with households endogenous.

Indirect requirements. Input requirements initiated in the second and succeeding rounds of purchases among the endogenous sectors. Total requirements minus direct requirements. They are obtained by inverting the matrix of technical or direct coefficients to get the direct plus indirect coefficients matrix and then subtracting from this the technical coefficients matrix to get the indirect requirements matrix.

Induced effects. Changes in output and household income resulting from change in household expenditures in response to direct, indirect, and induced changes in output. Induced effects are estimated by moving the household row and column into the processing sector of the I-O model.

Industry. See sector.

I-O Model. A depiction of the supply and demand relationships of an economy in equilibrium. It does not assume full employment of resources. It describes the transactions occurring in an economy for a given time period, normally a year. An I-O model can be designed for a metropolitan, a multicounty, State, or multistate economic area as well as a Nation.

Input requirements. See technical coefficients.

Interindustry transactions. The total value of purchases or sales by an I-O sector from or to another sector during the time period of the model.

Intermediate inputs. Those inputs which the model economy processing sectors purchase from each other, plus some imports of goods and services.

Intermediate output. Output sold to other processing sectors in the model economy to produce other goods and services.

Inverse coefficients. See direct plus indirect coefficients.

Leontief inverse. See direct plus indirect coefficients.

Output multipliers. See gross output multipliers and final demand multipliers.

Payments sector. Includes the purchases of primary and exogenous inputs by the processing sectors. It includes value added and imports.

Primary inputs. Primary inputs are different from intermediate inputs in that they are purchased directly from the primary supplier by the using industry. They cannot be produced by the processing sectors and must be supplied from outside the I-O model. Primary inputs are land, labor, and capital. Some primary inputs may be imported.

Processing sector. The first quadrant of the transactions table. It includes all sectors in an economy producing goods and services for final demand. These are the endogenous sectors of the model. All output of the processing sectors is either sold to final demand or to other processing sectors (to each other).

Sector. An aggregation of business enterprises, firms, establishments, or activities which produce the same or similar products, or which purchase the same inputs to use in production. Sectors are often defined by using the Standard Industrial Codes in classifying business activities into sectors. The terms sectors and industry are sometimes used interchangeably in I-O terminology. Each term, broadly defined, merely means the primary producing (selling) or purchasing (buying) unit in an I-O model. Often an I-O model combines several industries into one sector, as in highly aggregated models.

I-O analysts tend to refer to the individual aggregates of firms, establishments, or economic activities in an I-O table as industries and to a broad collection of activities or to one of the four quadrants of the I-O table as a sector. Miernyk has commented on industries and sectors.

> A transactions table consists of a collection of industries and sectors, and it might be helpful to distinguish between these concepts. According to Tiebout, 'industries refer to aggregates of firms producing similar products. Sectors refer to the kinds of markets that industries serve.' This is a useful distinction to keep in mind. When discussing the transactions table, however, we have at times referred to one

> collection of activities as the processing sector, and we have spoken of the individual activities outside this category as the final demand sector when they are considered collectively. Thus the term sector may be used at times with slightly different meanings, but the meaning which applies in each case should be clear from the context of the discussion. (35)

Miernyk, himself, appears to use the terms industry and sector interchangeably (35, pp. 8, 49, 50, and 78). In this report, industry and sector are used interchangeably, except when referring to the four quadrants of the I-O table; these are referred to as sectors.

Sectoring. Defining the industries or sectors of an I-O model.

Technical coefficients. The dollar value of inputs required by purchasing industry from a selling industry in order for the purchasing industry to produce a dollar's worth of output. Technical coefficients are computed by dividing each industry's purchases (column entries in an I-O model) by its total gross output. They are only computed for the processing sector. Technical coefficients are also referred to as direct requirements, direct coefficients, or input requirements.

Total change in employment. The direct employment change times the employment multiplier. Also, may be estimated by multiplying the total employment effects coefficient times the change in final demand.

Total change in income. The direct income change times the income multiplier. Also, may be estimated by simply multiplying the total income effects coefficient of a sector times that sector's change in final demand.

Total change in output. The product of a final demand multiplier times a change in final demand.

Total change in resource requirements. The direct plus indirect coefficients matrix times vectors of resource coefficients (direct requirements per unit of output by sector) times changes in final demand.

Total employment effects coefficient. Shows the total change in employment in the economy per unit change in final demand of a given sector. Computed by multiplying the direct plus indirect coefficients matrix times a row of direct employment coefficients.

Total gross outlay. The total value of an I-O sector's inputs (or its total purchases). It includes inventory depletions.

Total gross output. The total value of an I-O sector's output (or its total sales). Includes additions to inventories. It is the total of intermediate plus final goods. It is not the same as GNP, since GNP includes only final sales.

Total gross output multipliers. See gross output multipliers and final demand multipliers.

Total income effects coefficient. Shows the total change in income in the economy per unit change in final demand. The coefficients are computed for each sector in an I-O model as the sum of the products obtained by multiplying that sector's column of direct plus indirect coefficients times the row of direct income coefficients of the I-O model. (The direct plus indirect coefficients matrix times a row vector of income coefficients). In models with households endogenous, it is a household row entry of the direct plus indirect coefficients matrix.

Total requirements matrix. See direct plus indirect coefficients matrix.

Transactions table. A table of purchases and sales by industries used to describe the interindustry transactions of an economy. The transactions table, containing the basic information of the I-O model, shows who produces what and to whom they sell.

Transposed I-O matrix. A matrix in which column elements have been converted to row elements.

Type I multiplier. A final demand multiplier (or gross output multiplier) in which local household consumption expenditures (direct sales to local households) is defined as being exogenous to the model. Accordingly, these multiplier effects can be measured in terms of gross output, household income, and/or employment.

Type II multiplier. Defines local household consumption expenditures as being endogenous to the model. Local households are treated as another industry in the model. Households sell labor, rent property, provide financing, and perform services for which they receive wages, salaries, interest, and dividends. Their purchases of locally produced goods and services are considered to be parallel with those emanating from other local industrial sectors. This procedure allows one to take into account the induced effects of new rounds of local household consumption expenditures on the local economy. Accordingly, these multiplier effects can be measured in terms of gross output, household income, and/or employment.

Value added. The difference between the value of inputs purchased and the value of outputs sold. Value added includes wages and salaries, pensions, royalties, annuity payments, business taxes, depreciation, insurance claim payments, dividends, interest, rent, and profit or loss. Value added includes personal income of households before taxes.

Value added also includes retained earnings of businesses. Also included are corporation earnings which are paid in the form of stock dividends and compensation to employees in the form of stock. Transfer payments such as social security and veteran's payments appear in the value added row of an I-O model as payments by government to households, as do government payments to its civilian employees and military personnel.

Backward linkages. See induced effects.

Direct effects. The first wave of project induced impacts or reactions (beneficial and adverse) accruing to those persons or features of our environment that are the first recipients of project action. Direct impacts may be measured and evaluated in either physical or monetary units. Direct impacts are often called primary effects.

Efficiency gains. Producing more output with the same or less input, or producing the same output with less input. Efficiency gains also occur when output is provided to consumers at lower costs per unit.

External economies. Externalities resulting in benefits.

External diseconomies. Externalities resulting in harmful consequences, as opposed to benefits.

Externalities. 34/ An externality exists when the social costs and benefits of the actions of an individual, enterprise, or institution diverge from the private costs and benefits to that actor. Also frequently referred to as spillovers. The fundamental basis of the concept of an externality is interdependence and the absence of compensation. Those receiving the benefits, whether monetary or nonmonetary, do not pay for them. Those causing others in society to have higher costs do not pay anything to offset these higher costs. Externalities are generally broken into two categories: technological and pecuniary.

Indirect effects. Those repercussions that occur throughout the economy or environment in reaction to direct or primary project effects. For example, the value of changes in output of all businesses that serve the cotton producers of an area as they supply cotton producers more goods and services in response to an increase in cotton production caused by cotton producers taking advantage of the beneficical effects (direct effects) of a project. Indirect effects are frequently called secondary impacts.

Induced effects. Secondary market effects which result from change in the output of industries which supply inputs to the primary or direct impact activities and to the implementation of the plan itself. These are the so-called backward linkages induced by the plan.

Plan. The action to be undertaken in a specific area for the control, development, and use of water and related land resources. It may involve institutional changes or structural changes.

Primary effects. See direct effects.

---

34/ The USDA Procedures for Planning Water and Related Land Resources improperly uses secondary impacts and externalities interchangeably.

# APPENDIX B: NONSURVEY ESTIMATION TECHNIQUES FOR SUBSTATE REGIONAL INTERINDUSTRY MODELS

by Robert Niehaus

Several researchers in the Natural Resource Economics Division, Economics, Statistics, and Cooperatives Service (ESCS), U.S. Department of Agriculture, are estimating I-O models of substate regional economies. These efforts have focused on multicounty areas in Arkansas, Louisiana, New York, Ohio, and Oregon. One important result of this research has been the implementation of viable nonsurvey techniques for estimating small area interindustry models. A summary of the procedures used in this research in this area should be helpful to readers of this report. This Appendix concentrates on the most important points in the estimation methodology and the principal types of data required. 35/

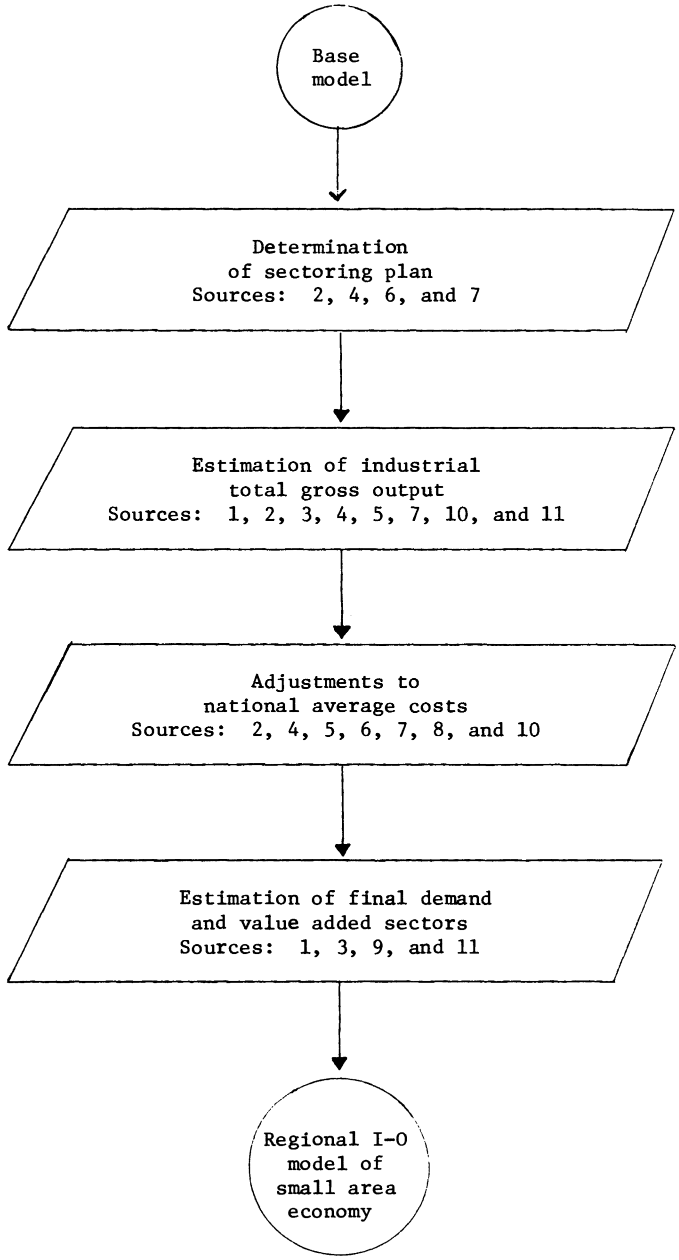
## An Overview of the Estimation Process

The flow chart (fig. 2) illustrates the primary steps involved in estimation. The researcher begins with a base model. This may be either a model for the State in which the study area is located, or it may be a disaggregated national I-O model of the United States. Current ESCS efforts have used both State models and the 390-sector and 480-sector U.S. models for 1967.

The small area model is estimated from the base model, following the principal steps outlined in figure 2. Estimation relies upon data on regional population, employment, income, production, and trade from a broad spectrum of published data sources. Any primary data that the researcher can collect at low cost is also used in this estimation, but the principal data sources are secondary ones. A partial list of these data sources appears in figure 2. Following is a discussion of each of the four principal steps.

35/ For a more detailed discussion of these estimation techniques, see: "An Assessment of Input-Output for Use in Project Impact Analysis and Identifying Critical Relationships in RC&D and Small Watershed Planning Areas," an unpublished ERS report by Clifford Jones; "A Proposal and Evaluation of a Regional Input-Output Modeling System," an unpublished Ph.D. dissertation, Michigan State University, 1975 by Sterling Stipe; "A Non-Survey Technique for Regional I-O Models: Application to River Basin Planning," by Richard N. Boisvert and Nelson L. Bills in A.E. Res. 76-19, Department of Agricultural Economics, Cornell University, August 1976; and "Forest Resource Management Analysis, An Analytical System for Investigating the Local Economic Impact of Forest Service Programs and Investments, Phase I Reports," by Ronald Drake, Stanley Randall, and John Wilkins, Economic Research Service, July 31, 1971.

Figure 2. Small area model estimation process




Sources

1. U.S. Census of Population and Housing
2. U.S. Census of Agriculture
3. U.S. Census of Governments
4. U.S. Census of Manufactures
5. U.S. Census of Wholesale and Retail Trade and Services
6. U.S. Dept. of Commerce, County Business Patterns
7. U.S. Dept. of Agriculture, Agricultural Statistics
8. U.S. Dept. of Interior, The Minerals Yearbook
9. U.S. Dept. of Agriculture, Economics, Statistics, and Cooperatives Service, Farm Income: State Estimates
10. Dun and Bradstreet, unpublished county data files
11. U.S. Dept. of Labor, Bureau of Labor Statistics, Employment and Earnings

(1) Determination of Sectoring Plan

Since the base model currently in use contains detail on as many as 480 different industries, some elimination and aggregation is essential to arrive at a model of workable dimensions. Many of these sectors can be eliminated from the analysis easily. Cotton, for example, is not produced in New York and can be readily eliminated in an analysis of that area. Other sectors will no doubt need to be aggregated. The objective in doing so is to reduce the number of sectors as much as possible without losing necessary accuracy in the key impact industries. County Business Patterns, the Census of Agriculture, and the Census of Manufactures are good sources to determine which industries are located within the region. The Standard Industrial Classification Manual is the basic reference concerning how similar industries should be aggregated.

(2) Estimation of Industrial Total Gross Output

The second stage in the estimation process is the calculation of total gross output in each industry. Much of this data is available from the sources listed above, as well as in other references listed in figure 2. Frequently, however, it is necessary to arrive at estimates of gross output which are not readily available from published sources. In particular, differences in industrial sector definition in the base year for which the model is being estimated and in the geographical delineation of the model make it impossible to rely simply on published gross output data.

When this is the case, the ESCS approach is to interpolate the necessary gross output data on the basis of the assumption of a stable relationship between output and employment in the region, industry, and time period under study. For example, estimation of the total gross output of the food processing sector of the lower Hudson River Valley of New York in 1967 might be based upon total regional employment in the sector in that year and the national or State output per worker ratio in food processing for 1967. Sources of data may vary depending upon the industry, region, or year, but the basic output-employment approach to interpolation of the required data is the dominant technique used in ESCS, as well as throughout the profession.

(3) Adjustments to Base Model Coefficients

The third, and perhaps most difficult, stage in estimation is making the necessary adjustments to the base model interindustry technical coefficients. At least three different types of adjustments are necessary.

(a) The first is an adjustment to the base model coefficients to represent differences in local technology from the base model average technology. Such an alteration requires specialized study of key industries and, when possible, primary data collection. When this analysis is not possible, the only alternative is to accept the base model average technology as being a reasonably accurate description of regional processes.

(b) The second adjustment to be made is for industry product mix. Every I-O table is really a composite of several more finely disaggregated sectors. For example, assume that the leather goods manufacturing sector is really a composite of the shoe, belt, and handbag industries. Suppose data are available in the base model regarding the purchases and sales of each of these less aggregated industries. Furthermore, suppose it is desirable to group these three industries into one leather goods manufacturing sector at the regional level. Then the desired regional purchase and sale coefficients should reflect the proportions in which the three subsectors are represented regionally, rather than the proportions in which the subsectors are present in the State or national economy. This means that aggregated regional technical coefficients should be weighted averages of less aggregated regional coefficients, where the weights are determined by the estimated gross output of each less aggregated industry in the region.

(c) The third and final type of adjustment to be made to the coefficients is to account for interregional trade. Depending upon the industry and region, this may be the most critical coefficient adjustment of all. In the U.S. economy as a whole, external trade is such a small proportion of total transactions that it may be effectively ignored. A small regional economy, on the other hand, is much more open. That is, it is much more dependent upon trade with other regions in the purchase of needed commodities and the sale of regional production.

What does this greater dependence imply in terms of estimating the regional purchase and sale coefficients? In the case of imports, the income and employment generated by production of the imported goods accrues to regions other than the study area. In the case of exports, the fact that regional production is exported rather than consumed in intermediate final uses within the region means that the income and employment associated with the further processing and consumption of the goods accrue outside the study region. Both import and export considerations imply that the base model interindustry transactions coefficients must be reduced in estimating the regional coefficients. For the sake of simplicity, this report ignores the possibility of interregional trade interactions (that is, feedbacks between regions as a result of expansion in the study area). For small regions, this simplification probably sacrifices little in terms of accuracy.

There are a number of ways to incorporate interregional trade flows into the analysis, several of which have been used by ESCS researchers. One procedure is an employment based location quotient. This technique reduces the base model sales coefficients of an industry by the ratio of the proportion of total employment in that industry locally to the proportion of total employment in that industry in the base region. A second approach is the use of the supply-demand pool technique, or a modified form of that technique. This method alters the base model sales coefficients for an industry by the ratio of total product demanded locally to total local production of that industry. Several other techniques, including cross-industry quotients and biproportional matrix adjustment have been explored by ESCS staff but are not now used to estimate the effects of interregional trade on the transactions coefficients.

### (4) Estimation of Final Demand and Value Added

Regional final demands are estimated by ESCS economists as three subaggregates for each industry: personal consumption expenditures, exports, and other final demand.

(a) Estimation of consumption is quite similar to the technique described above for adjusting the transactions coefficients for external trade. The relationship between consumption and gross output in the base model is adjusted according to area income, employment, or some combination of the two.

(b) Exports are estimated in the adjustment procedure described previously in the discussion of the region's external trade. Any excess of estimated gross output over regional demand represents an export from the region.

(c) Other final demands consist of regional investment, net inventory change, and Federal, State, and local government purchases in the area. Quantitatively speaking, these categories of final demand are not usually very important in the region. Therefore, they are usually treated as a residual, or are estimated directly from the relationship between these demands and gross output in the base model.

Value added in the region is also disaggregated into three categories, and is estimated in a fashion similar to that used in estimating final demand. The three subaggregates are industry payments to households, imports, and other value added.

(a) Household value added is estimated from the base model relationship between this variable and gross output, taking into account regional differences in income and employment.

(b) Imports are estimated from the trade adjustments discussed previously. Any excess of estimated local purchases over regional production represents an import into the region.

(c) Other value added consisting primarily of depreciation, taxes, and payments to households outside the region is estimated as a residual.

## Conclusions

On balance, this nonsurvey approach to estimating regional I-O models represents a relatively cost effective means for performing regional analyses. It is no doubt less accurate than survey based methods, but it is also much less expensive. It is probably at least as accurate for impact studies as the use of standardized multipliers, and is much more flexible in that the estimated regional model can be used for other types of analyses where standardized multipliers are of little use.

# APPENDIX C: DISPLAY OF IMPACTS OF PLAN IN PRINCIPLES AND STANDARDS ACCOUNT

by Clifford Jones and Sterling Stipe

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars | | Sector | 1,000 dollars |
| Project installation | | | | | | |
| 1. Channel construction and farm drainage | A. Increase in output 1. Value of increased output of goods and services | Livestock | 3/ .62 | A. Regional output 1. Region's share of project costs | Livestock | 4/ 0 |
| | | Other-agriculture | 2.48 | | Other-agriculture | 0 |
| | | Agricultural services | 2.85 | | Agricultural services | 0 |
| | | Mining | 13.04 | | Mining | 0 |
| | | Construction | 1,104.60 | | Construction | 0 |
| | | Manufacturing-food | 1.68 | | Manufacturing-food | 0 |
| | | Manufacturing-other | 318.23 | | Manufacturing-other | 0 |
| | | Manufacturing-wood | 16.09 | | Manufacturing-wood | 0 |
| | | Transportation-finance-insurance-real estate | 96.83 | | Transportation-finance-insurance-real estate | 0 |
| | | Retail-wholesale | 102.67 | | Retail-wholesale | 0 |
| | | Services | 84.88 | | Services | 0 |
| | | Total effects | 1,743.50 | | Total effects | 0 |
| | | Direct effects | 1,100.00 | | Direct effects | 0 |
| | | Indirect effects | 643.50 | | Indirect effects | 0 |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ Component | Beneficial effects 1/ Measure of effects | Adverse effects 1/ Component | Adverse effects 1/ Measure of effects | |
|---|---|---|---|---|---|
| | | | | Sector | 1,000 dollars |
| | | | 2. Loss of output from project displaced resources | Livestock | 5/ |
| | | | | Other-agriculture | |
| | | | | Agricultural services | |
| | | | | Mining | |
| | | | | Construction | |
| | | | | Manufacturing-food | |
| | | | | Manufacturing-other | |
| | | | | Manufacturing-wood | |
| | | | | Transportation-finance-insurance-real estate | |
| | | | | Retail-wholesale | |
| | | | | Services | |
| | | | | Total effects | |
| | | | | Direct effects | |
| | | | | Indirect effects | |

See footnotes on page 123.



Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | Adverse effects 1/ | | |
|---|---|---|---|---|---|
| | Component | Measure of effects | Component | Measure of effects | |
| | | | | Sector | 1,000 dollars |
| | | | 3. Losses due to reduced assistance payments from sources outside the region to otherwise unemployed or underemployed resources. | Livestock | 6/ |
| | | | | Other-agriculture | |
| | | | | Agricultural services | |
| | | | | Mining | |
| | | | | Construction | |
| | | | | Manufacturing-food | |
| | | | | Manufacturing-other | |
| | | | | Manufacturing-wood | |
| | | | | Transportation-finance-insurance-real estate | |
| | | | | Retail-wholesale | |
| | | | | Services | |
| | | | | Total effects | |
| | | | | Direct effects | |
| | | | | Indirect effects | |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | Number | | Sector | Number |
| Project installation | | | | | | |
| 1. Channel construction and farm drainage | B. Employment | Livestock | 7/ .038 | B. Employment | Livestock | 4/ |
| | 1. Increase in man-years of employment | Other-agriculture | .151 | 1. Loss in man-years of employment due to project installation costs | Other-agriculture | |
| | | Agricultural services | .060 | | Agricultural services | |
| | | Mining | .874 | | Mining | |
| | | Construction | 32.033 | | Construction | |
| | | Manufacturing-food | .037 | | Manufacturing-food | |
| | | Manufacturing-other | 16.548 | | Manufacturing-other | |
| | | Manufacturing-wood | .708 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 2.421 | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | 6.674 | | Retail-wholesale | |
| | | Services | 5.263 | | Services | |
| | | Total effects | 64.757 | | Total effects | |
| | | Direct Effects | 31.900 | | Direct effects | |
| | | Indirect effects | 32.857 | | Indirect effects | |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | Adverse effects 1/ | | |
|---|---|---|---|---|---|
| | Component | Measure of effects | Component | Measure of effects | |
| | | | | Sector | Number |
| | | | 2. Loss of man-years of employment due to project displaced resources | Livestock | ___ 5/ |
| | | | | Other-agriculture | ___ |
| | | | | Agricultural services | ___ |
| | | | | Mining | ___ |
| | | | | Construction | ___ |
| | | | | Manufacturing-food | ___ |
| | | | | Manufacturing-other | ___ |
| | | | | Manufacturing-wood | ___ |
| | | | | Transportation-finance-insurance-real estate | ___ |
| | | | | Retail-wholesale | ___ |
| | | | | Services | ___ |
| | | | | Total effects | ___ |
| | | | | Direct effects | ___ |
| | | | | Indirect effects | ___ |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | Adverse effects 1/ | | |
|---|---|---|---|---|---|
| | Component | Measure of effects | Component | Measure of effects | |
| | | | | Sector | Number 6/ |
| | | | 3. Employment losses due to reduced assistance payments from sources outside the region (man-years) | Livestock | ______ |
| | | | | Other-agriculture | ______ |
| | | | | Agricultural services | ______ |
| | | | | Mining | ______ |
| | | | | Construction | ______ |
| | | | | Manufacturing-food | ______ |
| | | | | Manufacturing-other | ______ |
| | | | | Manufacturing-wood | ______ |
| | | | | Transportation-finance-insurance-real estate | ______ |
| | | | | Retail-wholesale | ______ |
| | | | | Services | ______ |
| | | | | Total effects | ______ |
| | | | | Direct effects | ______ |
| | | | | Indirect effects | ______ |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars | | Sector | 1,000 dollars |
| Project installation | | | | | | |
| 1. Channel construction and farm drainage | C. Income | Livestock | 8/ .157 | C. Income | Livestock | 4/ |
| | 1. Increase in household income | Other-agriculture | .903 | 1. Loss of income due to region's share of project installation costs | Other-agriculture | |
| | | Agricultural services | .875 | | Agricultural services | |
| | | Mining | 5.764 | | Mining | |
| | | Construction | 290.510 | | Construction | |
| | | Manufacturing-food | .227 | | Manufacturing-food | |
| | | Manufacturing-other | 88.468 | | Manufacturing-other | |
| | | Manufacturing-wood | 6.211 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 35.827 | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | 40.555 | | Retail-wholesale | |
| | | Services | 35.140 | | Services | |
| | | Total effects | 504.250 | | Total effects | |
| | | Direct effects | 289.300 | | Direct effects | |
| | | Indirect effects | 214.950 | | Indirect effects | |

See footnotes on page 123.

Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | Adverse effects 1/ | | |
|---|---|---|---|---|---|
| | Component | Measure of effects | Component | Measure of effects | |
| | | | | Sector | 1,000 dollars |
| | | | 2. Loss of income due to project displaced resources within region | Livestock | 5/ |
| | | | | Other-agriculture | ______ |
| | | | | Agricultural services | ______ |
| | | | | Mining | ______ |
| | | | | Construction | ______ |
| | | | | Manufacturing-food | ______ |
| | | | | Manufacturing-other | ______ |
| | | | | Manufacturing-wood | ______ |
| | | | | Transportation-finance-insurance-real estate | ______ |
| | | | | Retail-wholesale | ______ |
| | | | | Services | ______ |
| | | | | Total effects | ______ |
| | | | | Direct effects | ______ |
| | | | | Indirect effects | ______ |

See footnotes on page 123.



Continued

Table 24--Regional development account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3--continued

| Project activity | Beneficial effects 1/ | | Adverse effects 1/ | | |
|---|---|---|---|---|---|
| | Component | Measure of effects | Component | Measure of effects | |
| | | | | Sector | 1,000 dollars |
| | | | 3. Loss of income due to reduced assistance payments from sources outside the region | Livestock | 6/ |
| | | | | Other-agriculture | |
| | | | | Agricultural services | |
| | | | | Mining | |
| | | | | Construction | |
| | | | | Manufacturing-food | |
| | | | | Manufacturing-other | |
| | | | | Manufacturing-wood | |
| | | | | Transportation-finance-insurance-real estate | |
| | | | | Retail-wholesale | |
| | | | | Services | |
| | | | | | |
| | | | | Total effects | |
| | | | | Direct effects | |
| | | | | Indirect effects | |

See footnotes on page 123.

Table 25--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 4-8

| Project activity | Beneficial effects 1/: Component | Beneficial effects 1/: Measure of effects: Sector | Beneficial effects 1/: Measure of effects: 1,000 dollars | Adverse effects 1/: Component | Adverse effects 1/: Measure of effects: Sector | Adverse effects 1/: Measure of effects: 1,000 dollars |
|---|---|---|---|---|---|---|
| Project associated 2/ | | | | | | |
| 1. Channel construction and farm drainage | A. Increase in output 1. Value of increased output of goods and services | Livestock | 9/ 371.16 | A. Regional output 1. Loss of output from land use changes due to better drainage | Livestock | 10/ |
| | | Other-agriculture | 305.40 | | Other-agriculture | |
| | | Agricultural services | 44.32 | | Agricultural services | |
| | | Mining | 8.53 | | Mining | |
| | | Construction | 617.67 | | Construction | |
| | | Manufacturing-food | 1,206.75 | | Manufacturing-food | |
| | | Manufacturing-other | 333.75 | | Manufacturing-other | |
| | | Manufacturing-wood | 12.67 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 205.71 | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | 148.71 | | Retail-wholesale | |
| | | Services | 150.08 | | Services | |
| | | Total effects | 3,404.75 | | Total effects | |
| | | Direct effects | 1,919.90 | | Direct effects | |
| | | Indirect effects | 1,484.85 | | Indirect effects | |

See footnotes on page 123.

Continued

Table 25--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 4-8--continued

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | Number | | Sector | Number |
| | B. Employment<br>1. Increase in man-years of employment | Livestock | 11/ 22.641 | B. Employment<br>1. Loss of man-years of employment due to project induced land use changes | Livestock | 10/ |
| | | Other-agriculture | 18.629 | | Other-agriculture | |
| | | Agricultural services | .931 | | Agricultural services | |
| | | Mining | .572 | | Mining | |
| | | Construction | 17.912 | | Construction | |
| | | Manufacturing-food | 26.549 | | Manufacturing-food | |
| | | Manufacturing-other | 17.355 | | Manufacturing-other | |
| | | Manufacturing-wood | .557 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 5.143 | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | 9.666 | | Retail-wholesale | |
| | | Services | 9.305 | | Services | |
| | | Total effects | 129.260 | | Total effects | |
| | | Direct effects | 59.647 | | Direct effects | |
| | | Indirect effects | 69.613 | | Indirect effects | |

See footnotes on page 123.

Continued

Table 25--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 4-8

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars | | Sector | 1,000 dollars |
| | C. Income | Livestock | 12/ 94.275 | C. Income | Livestock | 10/ |
| | 1. Increase in household income | Other-agriculture | 111.166 | 1. Loss of household income due to project induced land use changes | Other-agriculture | |
| | | Agricultural services | 13.615 | | Agricultural services | |
| | | Mining | 3.770 | | Mining | |
| | | Construction | 162.470 | | Construction | |
| | | Manufacturing-food | 162.911 | | Manufacturing-food | |
| | | Manufacturing-other | 92.783 | | Manufacturing-other | |
| | | Manufacturing-wood | 4.891 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 76.113 | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | 58.740 | | Retail-wholesale | |
| | | Services | 62.133 | | Services | |
| | | Total effects | 842.867 | | Total effects | |
| | | Direct effects | 392.486 | | Direct effects | |
| | | Indirect effects | 450.381 | | Indirect effects | |

See footnotes on page 123.

Table 26--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 9 through life of project

| Project activity | Beneficial effects 1/ Component | Beneficial effects 1/ Measure of effects: Sector | Beneficial effects 1/ Measure of effects: 1,000 dollars | Adverse effects 1/ Component | Adverse effects 1/ Measure of effects: Sector | Adverse effects 1/ Measure of effects: 1,000 dollars 10/ |
|---|---|---|---|---|---|---|
| Project associated 2/ 1. Channel construction and farm drainage | A. Increase in output 1. Value of increased output of goods and services | Livestock | 13/ 763.64 | A. Regional output 1. Loss of output from land use changes due to better drainage | Livestock | ______ |
| | | Other-agriculture | 626.21 | | Other-agriculture | ______ |
| | | Agricultural services | 714.29 | | Agricultural services | ______ |
| | | Mining | 2.92 | | Mining | ______ |
| | | Construction | 31.21 | | Construction | ______ |
| | | Manufacturing-food | 2,479.31 | | Manufacturing-food | ______ |
| | | Manufacturing-other | 321.41 | | Manufacturing-other | ______ |
| | | Manufacturing-wood | 8.02 | | Manufacturing-wood | ______ |
| | | Transportation-finance-insurance-real estate | 314.55 | | Transportation-finance-insurance-real estate | ______ |
| | | Retail-wholesale | 190.74 | | Retail-wholesale | ______ |
| | | Services | 213.48 | | Services | ______ |
| | | Total effects | 5,047.86 | | Total effects | ______ |
| | | Direct effects | 2,715.40 | | Direct effects | ______ |
| | | Indirect effects | 2,332.46 | | Indirect effects | ______ |

See footnotes on page 123.

Continued

Table 26--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 9 through life of project--continued

| Project activity | Beneficial effects 1/ Component | Beneficial effects 1/ Measure of effects: Sector | Beneficial effects 1/ Measure of effects: Number | Adverse effects 1/ Component | Adverse effects 1/ Measure of effects: Sector | Adverse effects 1/ Measure of effects: Number |
|---|---|---|---|---|---|---|
| | B. Employment<br>1. Increase in man-years of employment | Livestock | 14/ 46.582 | B. Employment<br>1. Loss of man-years of employment due to project induced land use changes | Livestock | 10/ |
| | | Other-agriculture | 38.200 | | Other-agriculture | |
| | | Agricultural services | 15.000 | | Agricultural services | |
| | | Mining | .196 | | Mining | |
| | | Construction | .905 | | Construction | |
| | | Manufacturing-food | 54.545 | | Manufacturing-food | |
| | | Manufacturing-other | 17.129 | | Manufacturing-other | |
| | | Manufacturing-wood | .353 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 7.864 | | Transportation-finance-insurance real estate | |
| | | Retail-wholesale | 12.398 | | Retail-wholesale | |
| | | Services | 13.236 | | Services | |
| | | Total effects | 206.408 | | Total effects | |
| | | Direct effects | 86.992 | | Direct effects | |
| | | Indirect effects | 119.416 | | Indirect effects | |

See footnotes on page 123.

Continued

Table 26--Regional development account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 9 through life of project

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars | | Sector | 1,000 dollars |
| | C. Income | Livestock | 15/ 193.965 | C. Income | Livestock | 10/ |
| | 1. Increase in household income | Other-agriculture | 227.940 | 1. Loss of household income due to project induced land use changes | Other-agriculture | |
| | | Agricultural services | 219.287 | | Agricultural services | |
| | | Mining | 1.291 | | Mining | |
| | | Construction | 8.208 | | Construction | |
| | | Manufacturing-food | 334.707 | | Manufacturing-food | |
| | | Manufacturing-other | 91.576 | | Manufacturing-other | |
| | | Manufacturing-wood | 3.096 | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | 116.384 | | Transportation-finance-insurance real estate | |
| | | Retail-wholesale | 75.342 | | Retail-wholesale | |
| | | Services | 88.381 | | Services | |
| | | Total effects | 1,360.177 | | Total effects | |
| | | Direct effects | 483.176 | | Direct effects | |
| | | Indirect effects | 877.001 | | Indirect effects | |

See footnotes on page 123.

Table 27--Regional development account: Estimated impacts of project OM&R, alternative Plan A, Project X, year 4 through life of project

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars | | Sector | 1,000 dollars |
| Project OM&R | A. Increase in output | Livestock | 16/ | A. Regional output | Livestock | 16/ |
| 1. Channel construction and farm drainage | 1. Value of increased output of goods and services due to OM&R | Other-agriculture | | 1. Region's share of OM&R costs | Other-agriculture | |
| | | Agricultural services | | | Agricultural services | |
| | | Mining | | | Mining | |
| | | Construction | | | Construction | |
| | | Manufacturing-food | | | Manufacturing-food | |
| | | Manufacturing-other | | | Manufacturing-other | |
| | | Manufacturing-wood | | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | | | Retail-wholesale | |
| | | Services | | | Services | |
| | | Total effects | | | Total effects | |
| | | Direct effects | | | Direct effects | |
| | | Indirect effects | | | Indirect effects | |

See footnotes on page 123.

Continued

Table 27--Regional development account: Estimated impacts of project OM&R, alternative Plan A, Project X, year 4 through life of project--continued

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | Number 16/ | | Sector | Number 16/ |
| | B. Employment | Livestock | | B. Employment | Livestock | |
| | 1. Increase in man-years of employment due to OM&R | Other-agriculture | | 1. Loss of man-years of employment due to region's share of OM&R costs | Other-agriculture | |
| | | Agricultural services | | | Agricultural services | |
| | | Mining | | | Mining | |
| | | Construction | | | Construction | |
| | | Manufacturing-food | | | Manufacturing-food | |
| | | Manufacturing-other | | | Manufacturing-other | |
| | | Manufacturing-wood | | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | | | Retail-wholesale | |
| | | Services | | | Services | |
| | | Total effects | | | Total effects | |
| | | Direct effects | | | Direct effects | |
| | | Indirect effects | | | Indirect effects | |

See footnotes on page 123.

Continued

Table 27--Regional development account: Estimated impacts of project OM&R, alternative Plan A, Project X, year 4 through life of project

| Project activity | Beneficial effects 1/ | | | Adverse effects 1/ | | |
|---|---|---|---|---|---|---|
| | Component | Measure of effects | | Component | Measure of effects | |
| | | Sector | 1,000 dollars 16/ | | Sector | 1,000 dollars 16/ |
| | C. Income | Livestock | | C. Income | Livestock | |
| | 1. Increase in household income due to OM&R | Other-agriculture | | 1. Decrease in household income due to region's share of OM&R costs | Other-agriculture | |
| | | Agricultural services | | | Agricultural services | |
| | | Mining | | | Mining | |
| | | Construction | | | Construction | |
| | | Manufacturing-food | | | Manufacturing-food | |
| | | Manufacturing-other | | | Manufacturing-other | |
| | | Manufacturing-wood | | | Manufacturing-wood | |
| | | Transportation-finance-insurance-real estate | | | Transportation-finance-insurance-real estate | |
| | | Retail-wholesale | | | Retail-wholesale | |
| | | Services | | | Services | |
| | | Total effects | | | Total effects | |
| | | Direct effects | | | Direct effects | |
| | | Indirect effects | | | Indirect effects | |

See footnotes on page 123.

Footnotes to Table 27

1/ Annual effects, not amortized or discounted (with reference to costs and benefits, respectively).

2/ Private business activity generated by projects after installation is completed. Private investment stimulated and encouraged by the government funded channel construction and related economic activity that is expected to extend well beyond the project installation period, such as increased farm production within the region resulting from local farmers installing onfarm drainage to take advantage of the drainage outlet provided by the new government constructed channel.

3/ Column entries for each sector were obtained by multiplying the construction column of the inverse matrix times the-$1.1 million change in final demand for construction output. Total effects were obtained by multiplying the construction sector's output multiplier times the-$1.1 million change in final demand. The sum of individual column entries will not exactly equal total effects because of rounding involved in the two procedures. Source: table 12.

4/ The region incurred no direct adverse effects since all channel construction costs were borne by the Federal Government. The secondary effects incurred due to the channel construction costs are considered beneficial economic activity.

5/ Channel construction of Plan A displaced no resources; however, where project installation does displace resources, such as loss of cropland due to permanent inundation in the reservoir pool area of a flood protection and/or water supply structure, such reduction in output due to displacement should be estimated and evaluated similarly to an output increase for the region.

6/ Any reductions in household income of this nature should be accounted for and assessed via the I-O model. This was not illustrated in the report, such changes in income would be converted to changes in personal consumption for each sector of the I-O model economy and assessed as reductions in final demand, similar to the way increases in final demand are handled.

7/ The sum of column entries and total effects will not equal because of rounding. Source: table 16.

8/ The sum of column entries will not equal total effects because of rounding. Source: table 18.

9/ The sum of column entries will not equal total effects because of rounding. Source: table 13.

10/ Adverse effects of project induced land use changes were not considered in the hypothetical example, but in actual project analysis they should be assessed and displayed as indicated.

11/ The sum of column entries will not equal total effects because of rounding. Source: table 16.

12/ The sum of column entries will not equal total effects because of rounding. Source: table 18.

13/ The sum of column entries will not equal total effects because of rounding. Source: table 14.

14/ The sum of column entries will not equal total effects because of rounding. Source: table 16.

15/ The sum of column entries will not equal total effects because of rounding. Source: table 18.

16/ Operation, maintenance, and repair costs and effects were not considered in the hypothetical example, but would be evaluated via I-O similar to project installation expenditures. Effects could be displayed by sector as indicated for output, employment, and income.

Table 28--Summary of regional effects of Plan A, Project X, on output, employment, and income, by time period 1/

| Time period | Beneficial effects | | | Adverse effects | | | Net effects (gain or loss) 3/ | | | Project costs | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output | Employment | Income | Output | Employment | Income | Output | Employment | Income | Federal | Regional |
| | 1,000 dollars | Man-years | --1,000 dollars-- | | Man-years | ---1,000 dollars-- | | Man-years | -----------1,000 dollars----------- | | |
| Years 1-3: | | | | | | | | | | | |
| Total | 1,743.5 | 64.8 | 504.3 | | | | | | | 1,000 | -- |
| Direct | 1,100.5 | 31.9 | 289.3 | | | | | | | -- | -- |
| Indirect | 643.5 | 32.9 | 214.9 | | | | | | | -- | -- |
| Years 4-8: | | | | | | | | | | | |
| Total | 3,408.0 | 129.3 | 842.9 | | | | | | | -- | -- |
| Direct | 1,921.6 | 59.7 | 392.5 | | | | | | | -- | -- |
| Indirect | 1,486.4 | 69.6 | 450.4 | | | | | | | -- | -- |
| Years 9 on: 2/ | | | | | | | | | | | |
| Total | 5,047.9 | 206.4 | 1,360.2 | | | | | | | -- | -- |
| Direct | 2,715.4 | 87.0 | 483.2 | | | | | | | -- | -- |
| Indirect | 2,332.5 | 119.4 | 877.0 | | | | | | | -- | -- |

1/ Estimated effects and costs are on an annual basis, and include all project effects assessed intables 16 and 18.
2/ Life of project.
3/ The adverse effects of the project were not estimated in this report so the net effects are not shown.

Table 29--Social well-being account: Estimated impacts of project installation, alternative Plan A, Project X, years 1-3

| Project activity | Beneficial and adverse effects 1/ | |
|---|---|---|
| | Component | Measure of effects |
| Project installation<br>1. Channel construction and farm drainage | A. Real income distribution | 1. Create 65 man-years of low to medium income jobs for area residents. 2/ |
| | | 2. Create regional income benefit distribution of $504,250 by income class as follows: 2/ |

| Income class (dollars) | Dollars of project generated household income accruing to each income class | Percentage benefits in class |
|---|---|---|
| Less than 3,000 | 28,500 | 5.65 |
| 3,000 - 10,000 | 379,257 | 75.21 |
| More than 10,000 | 96,493 | 19.41 |
| Total | 504,250 | 100.00 |

3. Local project costs to be borne by region total $0 with allocation of costs by income class as follows:

| Income class (dollars) | Dollars of project costs borne by each income class | Percentage contributions in class |
|---|---|---|
| Less than 3,000 | | |
| 3,000 - 10,000 | | |
| More than 10,000 | | |
| Total | | |

See footnotes at end of table 32.

Table 30--Social well-being account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 4-8

| Project activity | Beneficial and adverse effects 1/ | |
|---|---|---|
| | Component | Measure of effects |
| Project associated<br>1. Channel construction and farm drainage | A. Real income distribution | 1. Create 129 man-years of low to medium income jobs for area residents. 2/ |
| | | 2. Create regional income benefit distribution of $842,700 by income class as follows: 2/ |

| Income class (dollars) | Dollars of project generated household income accruing to each income class | Percentage benefits in class |
|---|---|---|
| Less than 3,000 | 210,000 | 24.92 |
| 3,000 - 10,000 | 420,000 | 49.84 |
| More than 10,000 | 212,700 | 25.24 |
| Total | 842,700 | 100.00 |

3. Local project costs to be borne by region total $0 with allocation of costs by income class as follows:

| Income class (dollars) | Dollars of project costs borne by each income class | Percentage contributions in class |
|---|---|---|
| Less than 3,000 | | |
| 3,000 - 10,000 | | |
| More than 10,000 | | |
| Total | | |

See footnotes at end of table 32.

Table 31--Social well-being account: Estimated impacts of project associated activities, alternative Plan A, Project X, years 9 through life

| Project activity | Beneficial and adverse effects 1/ | |
|---|---|---|
| | Component | Measure of effects |
| Project associated<br>1. Channel construction and farm drainage | A. Real income distribution | 1. Create 206 man-years of low to medium income jobs for area residents. 2/ |
| | | 2. Create regional income benefit distribution of $1,360,177 by income class as follows: 2/ |

| Income class (dollars) | Dollars of project generated household income accruing to each income class | Percentage benefits in class |
|---|---|---|
| Less than 3,000 | 408,053 | 30.00 |
| 3,000 - 10,000 | 544,070 | 40.00 |
| More than 10,000 | 349,981 | 30.00 |
| Total | 1,360,177 | 100.00 |

3. Local project costs to be borne by region total $0 with allocation of costs by income class as follows:

| Income class (dollars) | Dollars of project costs borne by each income class | Percentage contributions in class |
|---|---|---|
| Less than 3,000 | | |
| 3,000 - 10,000 | | |
| More than 10,000 | | |
| Total | | |

See footnotes at end of table 32.

Table 32--Social well-being account: Estimated impacts of project OM&R, alternative Plan A, Project X, years 4 through life

| Project activity | Beneficial and adverse effects 1/ | | | |
|---|---|---|---|---|
| | Component | Measure of effects | | |
| Project OM&R 3/ | A. Real income distribution | 1. Create __ man-years of low to medium income jobs for area residents. | | |
| 1. Channel construction and farm drainage | | 2. Create regional income benefit distribution of $__ by income class as follows: | | |
| | | Income class (dollars) | Dollars of project generated household income accruing to each income class | Percentage benefits in class |
| | | Less than 3,000 | | |
| | | 3,000 - 10,000 | | |
| | | More than 10,000 | | |
| | | Total | ______ | _____ |
| | | 3. Local project costs to be borne by region total $ with allocation of costs by income class as follows: | | |
| | | Income class (dollars) | Dollars of project costs borne by each income class | Percentage contributions in class |
| | | Less than 3,000 | | |
| | | 3,000 - 10,000 | | |
| | | More than 10,000 | | |
| | | Total | ______ | _____ |

1/ Effects are on an annual basis.
2/ Distribution of employment and income generated by project is based on arbitrary assumptions, in actual project analysis, earnings and skill groups could be examined for each economic sector, and employment and income changes could be allocated within sectors according to current situation and then totaled for the whole economy.
3/ Not estimated for OM&R in hypothetical example but in actual project should be assessed.



☆ U. S. GOVERNMENT PRINTING OFFICE : 1978 261-496/68